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Collateral Slack, Credit Concentration, and Bank Debt Adjustments: Evidence from Portuguese SMEs

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Abstract

Capital structure decisions are particularly relevant for small and medium-sized enterprises (SMEs) operating in bank-based financial systems, since these firms rely heavily on bank credit and face stronger credit market frictions. In this context, collateral and bank relationship structure may shape firms' subsequent bank borrowing. Prior research often uses tangible assets as proxies for collateral capacity, but these measures do not show whether tangible assets are already committed to existing secured bank credit. This dissertation contributes to the existing literature by analyzing the roles of *Collateral Slack*, a proxy for unused collateral capacity, and *Credit Concentration*, a proxy for the structure of bank-firm relationships, in Portuguese SMEs' bank debt adjustments.

The empirical analysis uses confidential data from Banco de Portugal, combining the Central Balance Sheet (CB) database with the Central Credit Register (CRC). The sample covers bank-borrowing Portuguese SMEs from 2011 to 2017 at the firm-year level. Linear panel models with firm and year fixed effects are used to examine how *Collateral Slack* and *Credit Concentration* are associated with subsequent changes in bank debt, scaled by lagged assets. The main explanatory variables are lagged to reduce simultaneity concerns, and the models are estimated separately for overall, short-term, and long-term bank debt.

The findings suggest that *Collateral Slack* is positively associated with subsequent changes in bank debt, mainly reflected in long-term bank debt changes. *Credit Concentration* is also positively associated with bank debt changes across both maturities. The interaction results suggest substitution only for short-term bank debt, while the overall and long-term results suggest complementarity instead. The additional analysis with *Personal Guarantees* and *Institutional Guarantees* leads to broadly similar results. Taken together, the evidence suggests that both *Collateral Slack* and *Credit Concentration* are relevant for SME bank debt adjustments, but not in the same way across debt maturities.

Keywords: SME financing; bank debt; collateral; bank relationship structure; credit concentration; debt maturity; Portugal.

JEL Codes: C23; G21; G32

Resumo

As decisões de estrutura de capital são particularmente relevantes para as pequenas e médias empresas em sistemas financeiros baseados no setor bancário, devido à sua maior dependência do crédito bancário e às maiores fricções de financiamento. Neste contexto, o colateral e a estrutura das relações bancárias podem influenciar os ajustamentos subsequentes da dívida bancária das empresas. Embora a literatura utilize frequentemente ativos tangíveis como *proxies* da capacidade colateral, estas medidas não mostram se esses ativos já estão associados a crédito bancário garantido. Esta dissertação contribui para a literatura ao analisar o papel da capacidade colateral não utilizada (*Collateral Slack*) e da concentração de crédito bancário no banco principal (*Credit Concentration*) nos ajustamentos da dívida bancária das PME portuguesas.

A análise empírica utiliza dados do Banco de Portugal, combinando a Central de Balanços com a Central de Responsabilidades de Crédito. A amostra compreende o período entre 2011 e 2017, ao nível da empresa-ano. São estimados modelos lineares em painel para a dívida bancária total, de curto e de longo prazo, com efeitos fixos ao nível da empresa e do ano, para examinar como as variáveis *Collateral Slack* e *Credit Concentration* estão associadas a alterações subsequentes na dívida bancária, normalizadas pelos ativos do período anterior.

Os resultados sugerem que o *Collateral Slack* está positivamente associado a variações subsequentes na dívida bancária, sobretudo no longo prazo. *Credit Concentration* também apresenta uma associação positiva em ambas as maturidades. Os resultados da interação sugerem substituição apenas na dívida de curto prazo, enquanto os resultados totais e de longo prazo são mais consistentes com complementaridade. A análise adicional com *Personal* e *Institutional Guarantees* apresenta resultados amplamente semelhantes. No geral, a evidência sugere que *Collateral Slack* e *Credit Concentration* são relevantes para os ajustamentos da dívida bancária das PME, mas não da mesma forma entre maturidades.

Palavras-chave: Financiamento das PME; dívida bancária; colateral; estrutura das relações bancárias; concentração de crédito; maturidade da dívida; Portugal.

JEL Codes: C23; G21; G32

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List of Acronyms

BPLIM — Banco de Portugal Microdata Research Laboratory

CB — Central Balance Sheet

CRC — Central Credit Register

EBITDA — Earnings Before Interest, Taxes, Depreciation, and Amortization

EC — European Commission

IES — Informação Empresarial Simplificada

LT — Long-Term

OV — Overall

p.p. — Percentage Points

POC — Plano Oficial de Contas

PPE — Property, Plant, and Equipment

ROA — Return on Assets

SMEs — Small and Medium-Sized Enterprises

SNC — Sistema de Normalização Contabilística

ST — Short-Term

TA — Total Assets

1. Introduction

Capital structure theory plays an essential role in shaping corporate decisions, particularly for small and medium-sized enterprises (SMEs) that operate in bank-based financial systems. SMEs' financing decisions tend to be especially sensitive to credit market frictions and firm-bank relationships, since these firms are more dependent on bank credit than large publicly traded firms (Beck et al., 2008; Berger & Udell, 1998). In this context, information frictions (Myers & Majluf, 1984), institutional constraints (Qian & Strahan, 2007), and asset pledgeability (Campello & Giambona, 2013; Shleifer & Vishny, 1992) are central to firms' financing choices. As a result, firms' bank borrowing and leverage dynamics are likely to be shaped both by the availability of collateralizable assets and by the broader financial environment in which they operate (Campello & Giambona, 2013; Qian & Strahan, 2007).

In this dissertation, collateral refers to business assets pledged by firms in commercial lending relationships. Collateral can help mitigate asymmetric information problems and agency costs. According to the classic financial contracting literature, collateral may be used to distinguish between safer and riskier borrowers, since it may be employed as a screening device in cases of adverse selection problems (Besanko & Thakor, 1987; Bester, 1985). Additionally, it can help to align the incentives of borrowers and lenders by making the cost of default higher for the borrower, which may reduce moral hazard problems (Boot et al., 1991). Building on the theoretical frameworks of Hart and Moore (1994) and Kiyotaki and Moore (1997), empirical studies examine the collateral channel, in which firms' borrowing capacity is linked to the value and pledgeability of their tangible assets (Chaney et al., 2012; Gan, 2007).

In line with this approach, existing studies have found that firms' leverage is influenced by their asset structure. Firms with a larger proportion of tangible assets tend to have higher leverage levels (Frank & Goyal, 2009; Rajan & Zingales, 1995; Titman & Wessels, 1988). This pattern is consistent with the view that tangible assets tend to retain greater liquidation value and are more easily pledged in debt contracts (Campello & Giambona, 2013; Shleifer & Vishny, 1992).

A closely related empirical approach is developed by Norden and van Kampen (2013), who examine the relationship between collateral and firms' leverage. They show that firms' debt financing is more sensitive to tangible assets, such as property, plant, and equipment (PPE),

than to other assets, such as inventories and receivables. They also find that the importance of the collateral channel varies over time and across firms, depending on financing conditions and firms' reliance on bank and trade credit. This approach provides a useful benchmark for the present dissertation, as it links firms' debt financing to asset-based borrowing capacity, especially in settings where firms rely heavily on bank credit.

Most of the existing evidence focuses on total leverage (Frank & Goyal, 2009; Rajan & Zingales, 1995), credit availability or credit volumes (Petersen & Rajan, 1994), or conventional tangibility measures (Campello & Giambona, 2013; Frank & Goyal, 2009), rather than on whether unused collateral capacity is associated with subsequent changes in bank debt and with the maturity structure of bank borrowing. This distinction is relevant because long-term debt is more closely linked to durable and pledgeable collateral, whereas short-term debt is less directly tied to such assets (Benmelech & Bergman, 2009; Vig, 2013). At the same time, studies that use tangibility as a proxy for collateral capacity do not consider whether reported tangible assets are actually available to support additional pledging, or whether they are already pledged (Frank & Goyal, 2009; Rajan & Zingales, 1995; Titman & Wessels, 1988). However, the balance-sheet stock of tangible assets is unlikely to coincide fully with the collateral that may effectively be used to support additional borrowing, since some assets may already be pledged or may not be easily enforceable in lending relationships. The difference between balance-sheet tangibility and the actual use of tangible assets as collateral, therefore, may contain relevant information about firms' potential unused collateral-based borrowing capacity.

On this basis, this dissertation moves beyond standard tangibility-based approaches by introducing *Collateral Slack*, a proxy for unused asset-based collateral capacity. Specifically, this proxy is intended to capture the extent to which the firm's tangible asset base is not already matched by bank credit explicitly secured by real collateral and may therefore indicate remaining capacity to support additional borrowing. By construction, it reflects unused collateral capacity rather than simply the stock of tangible assets reported on the balance sheet.

However, bank debt adjustments may also depend on the structure of firms' banking relationships. This is particularly relevant for SMEs, which are more opaque and rely more heavily on bank credit (Beck et al., 2008; Berger & Udell, 1998). For this reason, this dissertation also incorporates *Credit Concentration* as a proxy for the structure of bank-firm

relationships. Although this variable does not directly measure relationship lending intensity, it is related to this literature because the distribution of credit across banks may reflect the structure of bank-firm relationships (Berger & Udell, 1995; Boot, 2000; Petersen & Rajan, 1994). At the same time, it may also capture borrower dependence, reduced diversification across lenders, and potential hold-up problems, which may affect financing choices (Detragiache et al., 2000; Rajan, 1992). Considering *Credit Concentration* alongside *Collateral Slack* therefore allows the analysis to examine two related but conceptually distinct dimensions of bank borrowing: unused collateral capacity and the structure of bank-firm relationships.

Although the main analysis focuses on real collateral, bank debt may also be supported by other contractual mechanisms. This is relevant for SMEs because personal guarantees and institutional guarantees may reduce lender risk when firm-level collateral or borrower transparency is limited (Avery et al., 1998; Beck et al., 2010; Ono & Uesugi, 2009; Zecchini & Ventura, 2009). For this reason, the dissertation includes a brief additional analysis that introduces these guarantees as other forms of contractual credit support and examines whether the main associations remain similar after considering them.

The empirical analysis focuses on Portuguese SMEs from 2011 to 2017. Portugal provides a relevant context for this analysis because its financial system is strongly bank-oriented, with a comparatively limited role for non-bank financial intermediation. Recent evidence indicates that Portuguese firms, particularly SMEs, rely heavily on bank credit, while the firm population is mainly composed of SMEs, reinforcing the importance of bank lending in the Portuguese economy (Banco de Portugal, 2025; Instituto Nacional de Estatística, 2025; Pinto et al., 2023).

The sample period also includes years marked by macro-financial stress and subsequent adjustment in the Portuguese banking sector, following the sovereign debt crisis and the Economic Adjustment Programme implemented between 2011 and 2014 (Reis, 2015; Weise, 2020). From a theoretical perspective, periods of financial stress can make borrowing constraints more binding, as declines in asset values and tighter lending conditions may restrict firms' debt capacity (Kiyotaki & Moore, 1997). Against this background, Portugal provides a useful setting in which to examine whether collateral capacity and bank relationship structure are associated with subsequent changes in SMEs' bank debt.

This dissertation empirically examines how *Collateral Slack* and *Credit Concentration* are associated with *Net Change in Bank Debt* and with short- and long-term bank debt changes, using detailed firm-level data from Banco de Portugal. By moving beyond conventional tangibility-based measures and analyzing unused collateral capacity together with bank relationship structure, it contributes to the broader literature on SME finance, the collateral channel, and capital structure dynamics in the context of Portuguese bank lending. A brief additional analysis examines whether the main results remain similar after introducing other forms of contractual credit support.

The remainder of the dissertation is organized as follows. Section 2 reviews the literature on collateral-based lending, the collateral channel, relationship lending, and bank relationship structure. Section 3 describes the research design, including the sample construction, the construction of the main variables, and the empirical models used in the analysis. Section 4 reports the main empirical findings. Section 5 presents the additional analysis based on *Personal Guarantees* and *Institutional Guarantees*. Section 6 discusses the results in light of the theoretical mechanisms developed in the literature, and the final section presents the main conclusions and limitations of this dissertation.

2. Literature Review and Research Hypotheses

SMEs are particularly exposed to credit frictions arising from asymmetric information between borrowers and lenders. In this context, lenders may have difficulties in distinguishing between high-quality and low-quality projects, which can lead to credit rationing and constrain investment (Stiglitz & Weiss, 1981). The literature highlights two important mechanisms that may reduce these frictions: collateral and bank-firm relationships. These mechanisms are particularly relevant for SMEs, since their external finance often depends on bank credit and bank-borrower relationships (Berger & Udell, 1995; Berger & Udell, 1998; Boot, 2000).

This chapter reviews the main theoretical and empirical contributions on these two mechanisms. The discussion focuses first on the contractual role of collateral, then on the collateral channel as a borrowing-capacity constraint, and finally on relationship lending and bank relationship structure as mechanisms that may shape firms' access to bank credit and borrowing outcomes.

2.1. Theoretical and Empirical Foundations of Collateral

Collateral plays a central role in classic financial contracting theory, particularly in settings characterized by asymmetric information and agency problems between lenders and borrowers. These problems include adverse selection before contract signing and moral hazard after loan origination (Berger et al., 2011; Bester, 1987).

In this context, the literature identifies two views on the role of collateral: the adverse-selection view (*ex-ante*), which focuses on the role of collateral under private information before lending, and the moral hazard or incentive view (*ex-post*), which emphasizes the disciplinary role of collateral after credit is granted (Berger et al., 2011; Boot et al., 1991)[1]. Although these two perspectives imply different empirical predictions, they are not necessarily mutually exclusive, as both may operate at the same time. The importance of each perspective may vary depending on factors such as the collateral type, the risk of the borrower, and the institutional context (Berger et al., 2011; Berger et al., 2016).

Part of the literature focuses on the screening and signaling roles of collateral under adverse selection. According to Bester (1985), when borrower risk is not observable, collateral can

[1] Berger et al. (2011) show that ex-post mechanisms are generally more important. However, ex-ante mechanisms may still be relevant when banks have less prior information about the borrower.

act as a self-selection device. Safer borrowers may be willing to pledge collateral in order to obtain lower interest rates, while riskier borrowers may prefer contracts with higher interest rates and lower collateral requirements. In these models, collateral can support a separating equilibrium by acting as a signal of borrower quality (Besanko & Thakor, 1987; Bester, 1987). As a result, this mechanism may reduce credit rationing, since it helps lenders distinguish safer borrowers from riskier borrowers when information is incomplete (Besanko & Thakor, 1987; Stiglitz & Weiss, 1981).

However, the role of collateral as a screening device also has limitations. When lenders rely on collateral instead of carefully evaluating borrowers, their incentives to scrutinize projects may be weakened, since secured loans already provide some protection against losses (Manove et al., 2001). Empirical evidence also reflects this ambiguity, as collateralized loans tend to be associated with more favorable terms when collateral is liquid and enforceable, but may also be associated with riskier borrowers and higher default probabilities (Berger et al., 2016; Jiménez & Saurina, 2004)[2]. In this sense, the adverse-selection view does not provide a clear prediction on the relation between collateral and borrowing costs, since the direction of this relation depends on whether collateral signals borrower quality or reflects underlying risk and enforcement concerns (Berger et al., 2011; Berger et al., 2016).

The second perspective focuses on *ex-post* incentives and the moral hazard problem. In this view, collateral affects borrowers' behavior after the loan is granted by increasing the cost of default and reducing the incentives for excessive risk-taking or strategic default. Boot et al. (1991) analyze collateral in a framework that includes both private information and moral hazard, where collateral requirements vary with default risk and incentive problems. More generally, mechanisms that increase borrowers' stake in the project can reduce incentive problems by better aligning the incentives of borrowers and lenders (Holmström & Tirole, 1997).

Collateral can also affect the enforceability of future cash flows and, therefore, the firm's effective debt capacity. When repayment can be enforced partly through pledgeable assets, debt capacity increases under limited enforceability, allowing banks to lend more while still preserving repayment incentives (Hart & Moore, 1994; Rampini & Viswanathan, 2010). In this sense, collateral operates not only as a contractual device, but also as a borrowing

[2] Jiménez and Saurina (2004) find that collateralized loans are associated with higher ex-post credit risk. However, Berger et al. (2016) show that this relation may depend on the liquidity and type of collateral pledged.

constraint that helps determine firms' debt capacity and their ability to adjust bank borrowing over time (Almeida & Campello, 2007; Gan, 2007; Rampini & Viswanathan, 2010).

This enforcement mechanism is not frictionless. Although collateral is intended to discipline borrowers, its liquidation value can fluctuate over time and may depend on the interaction between borrower risk and collateral risk (Barbiero et al., 2024; Benmelech & Bergman, 2009). Therefore, collateral can help mitigate incentive and enforcement problems, but its effect on loan pricing and contractual terms depends on the underlying contracting frictions and on the characteristics of the collateral (Barro, 1976; Berger et al., 2011; Berger et al., 2016).

In addition, other theories contribute to this discussion by considering renegotiation, control rights, and bargaining power. Collateral can shape control rights during a distress situation and enhance the position of the lender during a renegotiation process (Bester, 1994; Gorton & Kahn, 2000). However, a firm's reputation and its ability to reduce information asymmetries over time may reduce the need for intensive bank monitoring in some lending settings (Diamond, 1991). At the same time, a close relationship between a firm and a bank can create informational capture and hold-up problems, weakening the firm's outside options and increasing borrowing costs over time (Greenbaum et al., 1989; Sharpe, 1990).

More recent evidence shows that the effects of collateral are not the same across all lending environments. The role of collateral depends on the structure of the lending relationship and on the quality of the assets pledged. For example, bank-borrower relationships may reduce the sensitivity of firms' investment decisions to changes in collateral value, thereby giving firms some protection against collateral shocks (Anderson et al., 2023). At the same time, the lending value of collateral depends on its effective liquidation value, which depends on how the risk of the borrower interacts with the risk of the collateral (Barbiero et al., 2024).

Overall, the views discussed above should not be seen as opposing, since they show that collateral can matter through information, incentives, and enforcement mechanisms. For this dissertation, the main implication is that collateral matters not only because firms hold tangible assets, but also because the pledgeability, prior use, and bank-specific assessment of those assets may affect debt capacity and firms' ability to increase bank borrowing over time. This also means that the same asset may not have the same collateral value in all lending relationships.

2.2. The Collateral Channel

Collateral can be seen as a constraint on borrowing capacity. In this view, firms' access to credit depends partly on the assets that can be pledged to lenders. This idea is closely related to the financial accelerator and collateral-channel literature, where pledgeable assets and borrower net worth influence borrowing limits, investment, and real activity (Bernanke & Gertler, 1989; Chaney et al., 2012; Kiyotaki & Moore, 1997).

Following this logic, the amount of external finance available to a firm is partly limited by the assets that can be credibly pledged to lenders (Almeida & Campello, 2007; Kiyotaki & Moore, 1997). As a result, changes in collateral values might affect borrowing capacity and influence firms' investment decisions and real activity (Bernanke & Gertler, 1989; Bernanke et al., 1999; Gan, 2007). This means that firms with more pledgeable assets, or higher unused collateral capacity, can sustain larger debt positions and may be better able to expand borrowing over time.

At the firm level, the collateral channel is based on the idea that assets differ systematically in their ability to support debt depending on their tangibility and their value in distress. According to traditional capital structure theories, tangible assets are more suitable to support debt than intangible or highly firm-specific assets, making them more effective in easing financing constraints (Harris & Raviv, 1991; Titman & Wessels, 1988). Consistent with this view, empirical studies find that tangibility and leverage are positively related after controlling for other relevant firm-specific factors, such as profitability, size, and growth opportunities (Frank & Goyal, 2009; Hall, 2012; Rajan & Zingales, 1995). For this reason, balance-sheet tangibility is commonly used as a proxy for potentially pledgeable assets. Although these studies typically examine leverage levels, they are relevant for the present dissertation because they show that asset structure can affect firms' debt capacity and, therefore, may also be relevant for firms' bank debt adjustments over time.

However, not all tangible assets serve as collateral in the same way. The value of collateral depends not only on accounting classification, but also on liquidation value and ability to support secured borrowing. Shleifer and Vishny (1992) show that the liquidation value of assets is state-dependent and depends on how assets can be sold outside the firm. This implies that when market or sectoral conditions deteriorate, collateral constraints may become more binding. In line with this, Benmelech and Bergman (2009) find that assets with higher liquidation value and stronger ability to support secured borrowing are associated with

more borrowing and more favorable credit terms. Campello and Giambona (2013) further show that differences in the collateral value of tangible assets help to explain leverage beyond traditional measures of asset tangibility. Taken together, these studies suggest that accounting-based tangibility is an imperfect proxy for collateral capacity, since assets with the same accounting value may not provide the same borrowing capacity, depending on how easily they can be pledged and used to secure bank credit.

A related empirical literature reinforces this interpretation through the study of exogenous variations in collateral value, especially through real estate markets. Assets such as real property tend to be pledgeable, and the value of these assets may fluctuate for reasons unrelated to the fundamentals of the firm. Chaney et al. (2012) show that an increase in the market value of corporate real estate can raise both investment and borrowing. Conversely, negative shocks to collateral value may have contractionary effects. For instance, Gan (2007) and Cvijanović (2014) provide evidence that changes in the value of collateral can affect firms' debt capacity and investment[3].

Despite this evidence, much of the firm-level literature relies on accounting-based proxies to measure collateral capacity, such as tangibility measures based on the ratio of property, plant, and equipment (PPE) to total assets (Frank & Goyal, 2009; Hall, 2012). These measures are relevant because they reflect the stock of potentially pledgeable assets, but they do not indicate how much collateral may already be committed to existing secured bank credit. This limitation is important because firms with similar levels of tangibility may still differ substantially in effective borrowing capacity depending on asset composition, collateral value, and the share of assets already pledged as collateral (Campello & Giambona, 2013; Norden & van Kampen, 2013).

This distinction is closely related to the work of Norden and van Kampen (2013), who show that leverage is not only influenced by aggregate measures of tangibility, but also by the composition of collateralizable assets. Using data from firms in the U.S., the authors find that different asset classes contribute differently to firms' debt capacity, with a greater contribution of PPE than inventories and receivables. Their results refine the standard

[3] Gan (2007) shows that negative collateral shocks can reduce firms' debt capacity and investment, while Cvijanović (2014) shows that changes in the value of pledgeable real estate can affect firms' capital structure decisions.

relationship between tangibility and leverage by showing that the collateral base is heterogeneous and that different asset classes contribute unevenly to borrowing capacity.

This raises a further empirical issue. If total tangibility only captures the potential stock of collateralizable assets, it does not show whether these assets may still support additional borrowing after considering existing secured debt contracts. In that case, the relevant distinction is not only the stock of tangible assets reported on the balance sheet, but also the extent to which this stock does not appear to be already matched by bank credit secured by real collateral.

Following this rationale, this dissertation combines balance-sheet information with credit-registry data to construct a proxy for unused collateral capacity, called *Collateral Slack*. The objective is not to directly measure the market value of pledged or unpledged collateral, but to approximate remaining asset-based collateral capacity by comparing balance-sheet PPE with the amount of bank credit explicitly secured by real collateral. Accordingly, the analysis seeks to move from a measure of potential pledgeability toward a proxy for remaining collateral-based borrowing capacity.

This argument can also be extended to firms' debt adjustments over time. The capital structure literature suggests that firms do not instantaneously move to a desired debt ratio, but instead adjust leverage gradually over time in the presence of adjustment costs (Flannery & Rangan, 2006; Leary & Roberts, 2005). More recent evidence further shows that cash-flow conditions and adjustment costs affect the speed of leverage adjustment (Faulkender et al., 2012). In this context, unused collateral capacity may facilitate subsequent increases in bank debt as firms adjust their borrowing positions over time.

Collateral capacity may also be relevant for the maturity structure of firms' debt. Assets with stronger collateral value and higher recovery value may be particularly relevant for long-term borrowing, where lenders are exposed to future default and collateral-value risk, since these assets strengthen debt capacity and improve lenders' recovery prospects in the event of distress (Barclay & Smith, 1995; Campello & Giambona, 2013). At the same time, collateral capacity may affect short-term debt by relaxing firms' overall borrowing constraints (Almeida & Campello, 2007; Chaney et al., 2012; Cvijanović, 2014). Therefore, although the collateral mechanism is expected to be stronger for long-term bank debt, it may also matter for short-term bank debt through a broader financing-constraint channel.

Overall, the literature points to a positive link between collateral capacity and firms' borrowing outcomes. In dynamic terms, this suggests that firms with higher unused collateral capacity may experience more positive subsequent changes in bank debt when financing needs arise. Since this mechanism may operate differently across maturities, the analysis considers both total bank debt changes and maturity-specific changes in short- and long-term bank debt.

Based on this reasoning, the first set of hypotheses is defined as follows:

Hypothesis 1: Higher *Collateral Slack* is positively associated with subsequent net changes in firms' bank debt.

Hypothesis 1a: Higher *Collateral Slack* is positively associated with subsequent net changes in firms' short-term bank debt.

Hypothesis 1b: Higher *Collateral Slack* is positively associated with subsequent net changes in firms' long-term bank debt.

2.3. Relationship Lending and Bank Relationship Structure

While collateral-based lending relies more directly on pledgeable assets, relationship lending focuses on the accumulation of soft information through repeated interactions between banks and borrowers. In the literature, relationship lending is characterized as a process through which banks generate proprietary information about borrower quality, firm characteristics, and business conditions over time, which cannot be fully captured by financial reports and other forms of hard information (Boot, 2000; Mester et al., 2007; Petersen & Rajan, 1994). By improving screening and monitoring, this informational advantage may ease borrowing constraints and allow banks to extend credit to informationally opaque firms, especially SMEs (Berger & Udell, 1995; Berger & Udell, 1998; Boot, 2000).

From a capital structure perspective, relationship lending can be viewed as a supply-side mechanism that affects firms' financing decisions. Stronger relationships between banks and firms may improve firms' access to liquidity and external finance, while also providing greater flexibility when financing conditions deteriorate (Beck et al., 2018; Boot, 2000). This role may become especially relevant during periods of stress, when banks may be more willing to continue lending to existing customers and access to external finance becomes more limited

(Beck et al., 2018; De Mitri et al., 2010). This reflects the intertemporal nature of lending relationships, as previous interactions can shape how banks respond to firms' financing needs over time (Dempsey & Faria-e-Castro, 2025).

However, relationship lending may also generate costs. For example, when banks accumulate more private information, they can gain informational monopoly power, which can lead to "hold-up" problems that increase the firms' dependence on their main lender (Rajan, 1992; Sharpe, 1990). In such cases, lenders may extract "informational rents" or offer less favorable contract terms, particularly when firms have limited outside options. For this reason, the association between relationship lending and subsequent net changes in bank debt is theoretically ambiguous, since better access to credit can be offset by reduced competition and borrower dependence. In practice, however, SMEs may still benefit from stronger banking relationships when the advantages of information accumulation and intertemporal support outweigh the costs of dependence (Boot, 2000).

Recent empirical work further highlights that different dimensions of bank-firm relationships can shape firms' financing decisions. Guida and Sabato (2017) find a positive association between relationship intensity and leverage among European firms, while multi-banking is also linked to leverage through a distinct channel. Braggion and Ongena (2019) show that exogenous shifts from single-bank to multi-bank relationships can affect firms' financing policies, including leverage, through changes in the structure of bank credit supply. More recently, Geelen et al. (2025) model relationship capital as evolving over time and show that it can affect both leverage and debt maturity decisions. Although these studies often focus on leverage levels, they are relevant to the present dissertation because they show that both the intensity and the structure of bank-firm relationships can affect firms' financing decisions and provide a basis for examining subsequent bank-debt adjustments.

An important implication of this literature is that bank-firm relationships matter not only because they may generate soft information, but also because their structure may affect firms' outside options, bargaining position, and access to bank credit. In empirical settings where direct measures of relationship lending intensity are unavailable, studies often use observable features of bank relationship structure, such as relationship length, the extent of multi-banking, or the concentration of borrowing in a main lender (Elyasiani & Goldberg, 2004;

Guida & Sabato, 2017; Kosekova et al., 2026; Memmel et al., 2007)[4]. Although relationship lending and bank relationship structure are related, they are not the same concept and may have different implications for financing decisions.

Based on this distinction, this dissertation focuses on bank relationship structure rather than on directly measuring relationship lending intensity. More specifically, *Credit Concentration* is used to capture the extent to which firms depend on a primary lender, measured by the share of total bank credit provided by the main bank. This is relevant for the present analysis because the dependent variable captures subsequent changes in bank debt. Therefore, the way bank credit is distributed across lenders may be related to how firms adjust bank borrowing over time. Although *Credit Concentration* does not directly measure soft information or relationship intensity, it captures an observable dimension of the bank-firm relationship: the firm's dependence on a primary banking partner.

The expected effect of *Credit Concentration* is theoretically ambiguous. Some studies suggest that firms' reliance on the main bank, or the concentration of debt in that bank, may improve access to credit, particularly for SMEs and smaller firms (Angori et al., 2019; Cenni et al., 2015). This positive role may be especially relevant when credit conditions become more restrictive, as more concentrated bank relationships may protect firms from credit reductions (De Mitri et al., 2010). However, greater concentration may also increase borrower dependence and expose firms to potential costs associated with concentration in the main bank (Kosekova et al., 2026). In the context of SMEs, this dissertation expects a positive association, since a more concentrated banking relationship may reflect a case where the continued support of the main bank outweighs the costs of dependence.

Accordingly, the following hypotheses are formulated:

Hypothesis 2: Higher *Credit Concentration* is positively associated with subsequent net changes in firms' bank debt.

Hypothesis 2a: Higher *Credit Concentration* is positively associated with subsequent net changes in firms' short-term bank debt.

[4] Elyasiani and Goldberg (2004) suggest that relationship-lending proxies do not always directly capture soft information. Similarly, Guida and Sabato (2017) highlight the difference between relationship intensity and banking relationship structure.

Hypothesis 2b: Higher *Credit Concentration* is positively associated with subsequent net changes in firms' long-term bank debt.

2.4. Bank-Firm Relationships, Credit Concentration and the Collateral Channel: Substitution or Complementarity

Considering the collateral channel and bank relationship structure together makes it possible to examine whether the role of collateral changes depending on the structure of firms' banking relationships. This is relevant because collateral and banking relationships may affect bank borrowing through different but related channels.

The literature approaches this interaction through two opposing mechanisms. The first is the substitution mechanism, according to which the importance of collateral may be lower when the bank-firm relationship plays a more central role in the lending decision. If borrowing depends more on the firm's reliance on its main bank, lending decisions may depend less on pledgeable assets, thereby weakening the link between collateral capacity and bank borrowing (Berger & Udell, 1995; Boot, 2000). Empirical support for this channel is provided by Berger and Udell (1995), who show that closer bank-firm relationships are associated with a lower probability of collateralized lending. Anderson et al. (2023) also show that firms with longer relationships display lower investment sensitivity to collateral shocks.

The second is the complementarity mechanism. In this case, banking relationships and collateral may reinforce each other in lending contracts. Collateral may remain important even when the main bank plays a central role in the firm's financing structure, since it can provide lender protection and reduce credit risk. Fanta (2016) provides evidence that banks use relationship banking and collateral jointly in SME lending, suggesting complementarity between the two. Similarly, Ono and Uesugi (2009) show that collateral remains important in main-bank relationships, particularly by strengthening monitoring incentives.[5]

Taken together, the literature suggests that banking relationships may modify the role of collateral in firms' borrowing outcomes through either substitution or complementarity. In the empirical analysis, this interaction is examined by considering whether *Credit Concentration*,

[5] Ono and Uesugi (2009), using evidence from Japanese SMEs, and Fanta (2016), using evidence from Ethiopian SMEs, also examine relationship lending and collateral. Their findings suggest that collateral may remain relevant even when firms have stronger or more central bank-firm relationships.

as an observable measure of bank relationship structure, modifies the association between *Collateral Slack* and subsequent changes in bank debt.

This dissertation treats the substitution mechanism as the baseline empirical expectation because, in the context of SMEs, higher reliance on the main bank may imply that subsequent borrowing depends more on the role of that lender and less on unused collateral capacity. Therefore, although *Collateral Slack* is expected to be positively associated with subsequent net changes in bank debt, this association is expected to become weaker when *Credit Concentration* is higher. However, the complementarity mechanism remains possible, since collateral may still be relevant when the main bank expands credit.

Given the substitution mechanism discussed above, the hypotheses are stated as follows:

Hypothesis 3: When *Credit Concentration* is higher, *Collateral Slack* is expected to be less strongly associated with subsequent net changes in firms' bank debt.

Hypothesis 3a: When *Credit Concentration* is higher, *Collateral Slack* is expected to be less strongly associated with subsequent net changes in firms' short-term bank debt.

Hypothesis 3b: When *Credit Concentration* is higher, *Collateral Slack* is expected to be less strongly associated with subsequent net changes in firms' long-term bank debt.

3. Methodology

3.1. Data Sources and Preparation

This study uses confidential microdata from two complementary datasets provided by Banco de Portugal through the Banco de Portugal Microdata Research Laboratory (BPLIM): the Central Balance Sheet (CB) (BPLIM, 2025) and the Central Credit Register (CRC) (BPLIM, 2026).

The CB dataset provides annual accounting information for non-financial corporations operating in Portugal, including income-statement and balance-sheet data (BPLIM, 2025). The CRC dataset contains detailed monthly information on credit exposures at the firm-bank level. In addition to outstanding amounts, the CRC provides information on contractual maturity and collateral type, which are central to the empirical analysis (BPLIM, 2026).

The empirical analysis uses firm-year observations. Although CRC data are available monthly at the firm-bank level, the analysis uses only the December observation of each year and subsequently aggregates credit exposures to the firm level. This approach ensures consistency with the annual accounting information available in the CB, and it is also in line with prior empirical work using Portuguese credit register data, where year-end credit exposures are matched to firm-level accounting variables (Bonfim, 2009; Bonfim et al., 2010). Using the December snapshot also reduces timing differences between credit stocks and balance-sheet variables and avoids averaging over months that may reflect substantial intra-year adjustments[6].

The dataset is constructed over the 2010–2017 period in order to preserve the information needed to construct lagged explanatory variables. Since 2010 is only used for lag construction, the empirical analysis itself focuses on the 2011–2017 period. This data window is chosen for two reasons. First, 2010 was the first year in which the Portuguese Sistema de Normalização Contabilística (SNC) was implemented[7]. The SNC replaced the earlier accounting system, Plano Oficial de Contas (POC), introducing important changes in the classification and measurement of balance-sheet items[8]. Starting the empirical analysis in

[6] Restricting the CRC to December removes 44,943,294 non-December monthly firm-bank observations. The remaining December firm-bank observations are then aggregated to the firm-year level, resulting in 2,238,048 firm-year observations, since multiple bank relationships held by the same firm in a given December are collapsed into a single observation.
[7] *Decreto-Lei n.º 158/2009* (2009, art. 1.º; art. 16.º).
[8] *Decreto-Lei n.º 158/2009* (2009, art. 11.º).

2011, therefore, improves comparability across observations under a common accounting regime. Second, 2017 is the last full year for which a December year-end observation can be used consistently, because the relevant CRC information is only available until August 2018 (BPLIM, 2026). As a result, the key firm-year variables used in this dissertation, particularly those related to contractual maturity, collateral usage, and firm-bank relationship structure, cannot be constructed consistently for later years. Extending the dataset beyond 2017 would therefore require changing the definition of core variables, which would compromise the internal consistency of the analysis.

The variables used in the empirical analysis are selected from these two datasets in order to construct the dependent variables, the main explanatory variables, and the control variables. Variables that are not required for the analysis are excluded at this stage. The restrictions used to define the final empirical sample are described in the next subsection.

3.2. Empirical Sample

The empirical sample is restricted to SMEs[9], as defined by the official size classification based on European Commission (EC) Recommendation 2003/361/EC[10] (European Commission, 2003). This focus is consistent with the objective of the dissertation since SMEs constitute a relevant setting in which to study bank credit, collateral capacity, and bank-firm relationships, given the central role of banks in small-firm finance (Beck et al., 2008; Berger & Udell, 1995).

Additional restrictions are imposed in order to ensure a homogeneous and economically relevant sample. Firms must satisfy two complementary activity criteria that are available in the CB data[11]. They must be classified as being in business at the end of the fiscal year and satisfy the broader economic activity criterion developed by Banco de Portugal, which combines information from Informação Empresarial Simplificada (IES) with other complementary sources (BPLIM, 2025).

Since CRC credit exposures are measured using the December snapshot, the sample is limited to firms with fiscal years ending in December. To ensure comparability across firms and over time, only firms with regular accounting periods are selected, defined as periods

[9] Restricting the sample to SMEs, using the official EC classification, excludes 8,053 firm-year observations classified as large enterprises.
[10] SMEs are defined according to EC Recommendation 2003/361/EC, based on employment (< 250 employees) and either turnover (≤ €50 million) or balance sheet total (≤ €43 million).
[11] Among CB observations, excluding firms not classified as being in business removes 135,001 firm-year observations. Banco de Portugal's economic activity criterion removes a further 27,237 observations.

lasting between 350 and 370 days. Firms in liquidation are also excluded because the nature of their financing decisions is unlikely to reflect regular operating conditions.[12]

The sample is also restricted to firms with positive total assets and positive book equity[13]. Positive total assets are required because several variables are scaled by assets, including the dependent variable, which uses lagged total assets as the denominator. The restriction to firms with positive book equity excludes observations with a non-positive accounting equity base. This criterion is consistent with Albuquerque et al. (2018), who exclude firms with negative equity because the factors underlying this situation are outside the scope of their analysis. However, negative equity is not uncommon among Portuguese firms and is related to firm characteristics such as age, size, and sector (Albuquerque et al., 2018). Therefore, this restriction may bias the sample towards firms with stronger accounting capital positions. Accordingly, the results should be interpreted as applying to SMEs with positive book equity.

Further restrictions retain private corporate legal forms and exclude sectors whose balance-sheet structure, financing patterns, or institutional setting differ systematically from those of standard private non-financial corporations. This is consistent with empirical studies that focus on private firms or private non-financial firms when examining financing decisions (Casino-Martínez et al., 2023; Díaz-Díaz et al., 2016). Accordingly, financial activities, public administration, education, health and social services, membership organizations, and household or extraterritorial activities are excluded in order to preserve the focus on a standard private corporate environment.[14]

Lastly, the combined dataset only retains firm-year observations that are successfully matched between the CB and CRC datasets and have strictly positive effective bank debt[15]. This implies the exclusion of observations with no bank debt, which is appropriate given the focus of the dissertation and avoids conflating the analysis with the separate question of why

[12] Among the remaining CB observations, restricting the sample to firms with a fiscal year ending in December excludes 12,885 firm-year observations. Requiring regular accounting periods removes a further 110,018 observations, and excluding firms in liquidation removes an additional 5,663 observations.

[13] Requiring positive total assets and positive equity excludes a further 4,568 and 761,135 firm-year observations, respectively. The positive book equity restriction corresponds to 20.61% of unique firms at this stage of the sample construction.

[14] Among the remaining CB observations, restricting the sample to standard private corporate legal forms excludes 125,736 firm-year observations. Sector restrictions remove a further 14,516 observations in financial activities; 34 in public administration; 21,277 in education; 125,845 in health and social services; 95 in membership organizations; and 11 in household or extraterritorial activities.

[15] After the previous restrictions, matching the CB dataset with the annual CRC dataset excludes 779,150 firm-year observations without a corresponding CRC record. Restricting the matched sample to observations with strictly positive effective bank debt removes a further 69,979 observations.

some firms carry no debt at all, in line with the broader discussion on zero-leverage firms (Sardo et al., 2024; Strebulaev & Yang, 2013). Accordingly, the analysis focuses on firms with positive bank debt exposure, that is, active bank borrowers, and does not examine why some firms have no bank debt or why they move out of bank borrowing.

In addition, firm-year observations must contain all the information needed to construct the key variables used in the empirical analysis, including bank debt changes, the lagged asset denominator, as well as the main explanatory and control variables. Observations with missing data in any variable required for that specification are excluded accordingly[16].

After applying the above sample restrictions, the final matched dataset is an unbalanced panel consisting of 539,448 firm-year observations from 146,644 firms over the 2011–2017 period. All variables are constructed at the firm-year level[17].

The regression sample is smaller than the final matched dataset because additional requirements are applied at the estimation stage. In particular, each specification requires lagged explanatory variables and complete information for the variables included in that model. As a result, the number of observations differs across regressions depending on the lag structure and on the variables included in each model.

3.3. Variable Definitions

The main continuous variables are winsorized at the 1st and 99th percentiles to reduce the impact of extreme observations, which is a widely used approach in empirical corporate finance research (e.g., Frank & Goyal, 2009; Norden & van Kampen, 2013). Selected variables are additionally transformed for estimation purposes in order to reduce skewness and compress the upper tail of their distributions. In most cases, transformations are applied after winsorization. An exception is *Firm Size*, which is calculated as the natural logarithm of total assets before winsorization. By contrast, *Collateral Slack* and *Credit Concentration* are not winsorized, since their support is naturally bounded between zero and one, and their boundary values are economically meaningful. The definitions of the main variables used in the empirical analysis are presented below[18].

[16] Requiring complete firm-year information for the dependent variable, the main explanatory variables, and the control variables used in the regressions excludes a further 407,892 observations.
[17] A more detailed and visual summary of the sample construction and the number of observations excluded at each stage is reported in Appendix A – Sample Construction, Table A1.
[18] Detailed information on the computation of all variables used in the analysis can be found in Appendix B - Research Variables, Table B1.

3.3.1. Dependent variables

The main dependent variable is *Net Change in Bank Debt*, defined as the annual change in total effective bank debt scaled by lagged total assets and expressed in percentage terms. Total effective bank debt is obtained from CRC credit exposures aggregated at the firm level in December of each year, while total assets are obtained from CB. Effective bank debt follows the CRC definition of effective credit, which includes all credit states except potential credit (BPLIM, 2026). Formally,

$$\boldsymbol{NetChangeBankDebt_{i,t}}(\%) = \frac{\boldsymbol{BankDebt_{i,t} - BankDebt_{i,t-1}}}{\boldsymbol{Assets_{i,t-1}}} \times 100$$

This variable captures the net increase or decrease in outstanding bank debt relative to the firm's size at the beginning of the period. Positive values indicate an expansion of bank debt, while negative values indicate a reduction. Accordingly, this measure should be interpreted as a change-based measure of bank borrowing, expressed as a percentage of lagged assets, rather than as a conventional leverage ratio in levels.

The empirical capital structure literature recognizes that firms' debt policies can be studied not only through leverage levels, but also through changes in debt over time. While leverage ratios capture the stock of debt accumulated by the firm, changes in debt capture financing adjustments during a given period. Faulkender et al. (2012) and Denis and McKeon (2012) provide this broader dynamic perspective by studying leverage adjustments and debt-financing decisions over time. More specifically, Roberts and Sufi (2009) use net debt issuance scaled by lagged assets to measure debt financing activity relative to firm size.

In the present dissertation, this logic is adapted to the bank financing context by using total effective bank debt from CRC rather than total corporate debt. This allows the dependent variable to capture whether firms expand or reduce their bank borrowing over time, relative to their initial asset base, which is closely aligned with the analysis of SME bank debt adjustments.

This specification is particularly relevant because *Collateral Slack* is partly related to the firm's existing secured debt position. If bank financing were measured only through contemporaneous debt stocks, the estimated relationship could partly reflect a mechanical link between outstanding secured debt and available collateral capacity. Moreover, new bank borrowing, especially if secured, may itself affect the measured level of *Collateral Slack* by using part of the firm's available collateral capacity. By using the annual change in bank debt

between year-end observations, the analysis focuses on net movements in bank financing over the year.

The use of lagged assets in the denominator makes the variable comparable across firms of different sizes. At the same time, because lagged assets are predetermined, variation in the dependent variable is driven by changes in bank debt rather than by contemporaneous changes in firm size. This is preferable to using a change in the debt-to-assets ratio, which may reflect changes in both bank debt and assets.

Since the variable is based on annual changes in outstanding CRC exposures, it should be interpreted as a net measure rather than as gross loan origination. It captures the overall change in bank debt over the year, reflecting both increases and reductions in outstanding bank debt.

Net Change in Bank Debt is also examined by contractual maturity based on CRC maturity-specific credit exposures. Short-term and long-term bank debt are derived from effective credit using original maturity, with short-term debt defined as credit up to one year, and long-term debt as credit above one year. The maturity-specific dependent variables are calculated using the same change-based approach as the main dependent variable, but using short-term and long-term effective bank debt instead of total effective bank debt. For this reason, these variables should be interpreted as separate measures of bank debt changes by maturity, rather than as an exact decomposition of total bank debt.

This approach is consistent with the view that debt maturity is an important dimension of firms' financing structure, since short-term and long-term debt may reflect different financing choices (Barclay & Smith, 1995; Flannery, 1986). In addition, using original maturity makes it possible to focus on firms' *ex-ante* financing decisions, rather than on residual maturity observed after loan origination. Since *Net Change in Bank Debt* can take positive, zero, and negative values, it is included in the empirical estimations without further transformation.

3.3.2. Independent variables

Collateral Slack

Collateral Slack is intended to provide a more specific proxy for potential collateral capacity than asset tangibility alone. The measure is particularly motivated by Norden and van Kampen (2013), who use property, plant, and equipment (PPE) to capture an important part

of firms' collateralizable assets. However, while asset tangibility captures the existence of tangible assets, it does not indicate whether those assets may already be associated with secured borrowing. For this reason, this dissertation constructs a proxy that adjusts PPE by the outstanding amount of bank credit secured by real collateral. It is defined as:

$$\boldsymbol{CollSlack_{i,t-n} = \frac{PPE_{i,t-n} - SecuredRealCredit_{i,t-n}}{PPE_{i,t-n}} \; if \; PPE_{i,t-n} > 0}$$

where $\boldsymbol{PPE_{i,t-n}}$ denotes property, plant and equipment, and $\boldsymbol{SecuredRealCredit_{i,t-n}}$ refers to the outstanding amount of bank credit secured by real collateral, including both mortgaged and non-mortgaged real collateral[19].

The measure is only computed for observations with positive PPE, since PPE is the denominator of the ratio. Observations with zero or missing PPE are therefore excluded from the analysis. Negative values are also set to zero because they indicate that bank credit secured by real collateral exceeds the PPE used as the balance-sheet proxy for tangible collateral. Since slack refers to "excess" or "unused" resources, these values are not treated as meaningful negative slack, which is in line with the broader slack literature (e.g., Bentley & Kehoe, 2020). The variable is also capped at one, since the proxy cannot exceed the PPE-based collateral. After these adjustments, *Collateral Slack* ranges from zero to one.

Higher values of *Collateral Slack* suggest that a larger share of the firm's PPE is not matched by outstanding bank credit secured by real collateral. In practice, this may indicate more potential PPE-based collateral capacity to support additional borrowing, while values close to zero suggest that this collateral base is already largely absorbed by secured real credit. This is consistent with the theoretical argument that pledgeable assets can support firms' borrowing capacity (Hart & Moore, 1994; Rampini & Viswanathan, 2010), and with empirical evidence showing that asset tangibility and collateralizable assets are related to firms' debt capacity and leverage (Norden & van Kampen, 2013; Rajan & Zingales, 1995).

Collateral Slack should be interpreted as a proxy for unused collateral capacity, rather than as a direct measure of all pledgeable assets. The measure is based on balance-sheet PPE and bank credit secured by real collateral. Therefore, it does not capture the exact value of the collateral pledged, the haircut or the valuation applied by banks, or the value that these assets

[19] The CRC manual states that, when the same asset secures more than one loan, the guarantee amount is distributed across the corresponding exposures in proportion to their outstanding amounts. This reduces the risk of treating the same pledged asset as a cumulative collateral amount across loans (BPLIM, 2026).

may have in liquidation. Since PPE is measured at book value, it may differ from market or liquidation values. The measure also does not show whether specific assets are already pledged or whether they can still be used to support additional borrowing. In addition, it excludes other forms of credit support, such as personal or institutional guarantees. In the empirical estimations, *Collateral Slack* is included without further transformation.

Credit Concentration

Following the literature on bank relationship structure within the broader relationship-lending framework, the empirical analysis proxies relationship structure by the concentration of credit exposure in the firm's main bank, which corresponds to the share of total bank credit supplied by that lender. The variable, *Credit Concentration*, is constructed as:

$$\boldsymbol{CreditConc_{i,t-n}} = \max_{b}\left(\frac{\boldsymbol{E_{i,b,t-n}}}{\sum_{k}\boldsymbol{E_{i,k,t-n}}}\right)$$

where $\boldsymbol{E_{i,b,t-n}}$ denotes the Central Credit Register (CRC) effective bank credit exposure of the bank $\boldsymbol{b}$ to the firm $\boldsymbol{i}$ in the December snapshot at time $t-n$, and $\sum_{k}\boldsymbol{E_{i,k,t-n}}$ denotes the firm's total bank credit across all lending banks.

The proxy captures the concentration dimension of the bank-firm relationship, namely the dependence of the firm on a main lender. Similar measures have been used in the empirical literature to characterize relationship structure through the concentration of borrowing in a main lender or the share of bank debt provided by the main lender (Kosekova et al., 2026; Memmel et al., 2007; Stein, 2015).

Although a higher value may reflect a more central role of the main bank in the firm's financing structure, it may also imply a higher degree of dependence on the bank, reduced outside options, or limited access to other potential lenders. Therefore, this variable is viewed as a proxy for the structure of the bank-firm relationship, rather than as a direct measure of informational intensity.

Higher values indicate greater dependence on the primary lender, while a value of one indicates that all bank credit is provided by a single lender. In the empirical analysis, *Credit Concentration* is included without further transformation.

3.3.3. Control Variables

The empirical models also include a set of standard capital structure controls commonly used in the literature (Frank & Goyal, 2009; Rajan & Zingales, 1995). These controls capture firm-

level characteristics that may be associated with firms' debt financing decisions and bank borrowing outcomes.

Firm Size is measured as the natural logarithm of total assets. Differences in firm size may be associated with different borrowing patterns, since larger firms tend to face lower information asymmetries, better access to external finance, and lower relative default risk.

Firm Age is measured as the number of years since incorporation. Older firms may face lower information asymmetry and thus display different borrowing patterns (Berger & Udell, 1998).

Operational Return on Assets (ROA) captures the profitability of the firm and is defined as Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) scaled by total assets, expressed in percentage terms.

Liquidity is proxied by the current ratio, defined as current assets divided by current liabilities. This variable captures short-term financial flexibility.

Finally, *Financial Pressure* is measured as interest expenses scaled by EBITDA and proxies the burden of interest expenses relative to firms' operating earnings. It is related to the inverse of interest-coverage-type measures used in the literature to assess debt-servicing capacity and financial distress (Asquith et al., 1994). *ROA, Liquidity* and *Financial Pressure* are directly provided in the BPLIM data. The empirical models are estimated both with and without *Financial Pressure* to assess whether the main results are sensitive to debt-servicing pressure.

Regarding their empirical treatment, and consistent with the variable treatment described at the beginning of this section, the *Firm Size* variable is included in logarithmic form; *Firm Age* and *ROA* are included in levels; *Liquidity* enters as the natural logarithm of the winsorized current ratio; and *Financial Pressure* is included using the $\ln(1 + x)$ transformation.[20]

All explanatory variables are introduced with one- and two-period lags in the empirical specifications in order to mitigate simultaneity concerns and alleviate potential reverse causality.

3.4. Descriptive Statistics

Descriptive statistics for the variables used in the empirical analysis are presented in Table 1.

[20] For the variables used in logarithmic form, the log transformations are valid in the estimation sample: total assets are positive due to the sample restrictions, *Liquidity* is positive, and *Financial Pressure* is greater than -1.

Table 1: Descriptive Statistics of Key Variables

This table presents descriptive statistics for the variables included in the empirical analysis. Variable definitions and transformations are provided in Appendix B – Research Variables. Net Change variables are scaled by lagged total assets (TA) and reported as a percentage of lagged total assets. *Collateral Slack* and *Credit Concentration* are bounded between zero and one. Because of BPLIM confidentiality restrictions, minimum and maximum values cannot be reported. Most continuous variables are winsorized at the 1st and 99th percentiles, except *Collateral Slack* and *Credit Concentration*. The descriptive sample includes 539,448 firm-year observations over the 2011-2017 period, while 2010 is used only to construct lagged variables.

Variable	Mean	St. Dev.	p25	p50	p75	Skew.	Kurt.	Obs.	Unit
Net Change in Bank Debt									
OV Net Change in Bank Debt	0.140	12.870	-5.540	-1.678	2.115	2.07	10.76	539,448	% lagged TA
ST Net Change in Bank Debt	-0.044	6.359	-0.645	0.000	0.420	0.14	9.91	539,448	% lagged TA
LT Net Change in Bank Debt	0.127	11.362	-4.843	-1.440	0.860	2.26	11.48	539,448	% lagged TA
Collateral Channel									
Collateral Slack	0.839	0.308	0.843	1.000	1.000	-1.84	4.96	539,448	Ratio [0,1]
Bank Rel. Structure									
Credit Concentration	0.818	0.220	0.634	0.953	1.000	-0.84	2.36	539,448	Ratio [0,1]
Control Variables									
Firm Size	12.986	1.442	11.966	12.853	13.881	0.42	2.99	539,448	$\ln(TA)$
Firm Age	16.816	11.535	8.000	14.000	22.000	1.44	5.48	539,448	Years
ROA	11.088	9.839	4.337	8.207	14.683	1.86	7.26	539,448	% of TA
Liquidity	0.644	0.958	0.146	0.551	1.119	0.15	4.76	539,448	$\ln(x)$
Financial Pressure	0.140	0.196	0.010	0.066	0.190	2.60	11.52	539,448	$\ln(1+x)$

These statistics show that *Overall (OV) Net Change in Bank Debt*, expressed in percentage points of lagged total assets, has a mean of 0.140 and a median of -1.678, which indicates that changes in bank debt are, on average, small relative to firm size. Regarding the maturity-specific measures, *Short-Term (ST) Net Change in Bank Debt* has a mean closer to zero, while *Long-Term (LT) Net Change in Bank Debt* has a higher standard deviation, suggesting greater variation across firm-year observations. Figure C1 in Appendix C - Supplementary Descriptive Evidence shows that *Net Change in Bank Debt* was negative in the first years of the sample, both for the overall measure and for the maturity-specific measures, but became positive from 2014 onwards. This is consistent with the economic context of the sample period, as credit conditions in Portugal were tighter during the earlier years of the sample.

Regarding *Collateral Slack,* the mean is 0.839. In addition, both the median and the 75th percentile are equal to 1.000, which indicates that this variable is highly concentrated near the upper bound of the distribution. Although the mean is slightly below the 25th percentile,

this reflects the presence of some observations with lower *Collateral Slack* values. This suggests that, for a large share of firm-year observations, a substantial share of tangible assets appears not to be matched by bank credit explicitly secured by real collateral. This pattern is consistent with the idea that tangible assets are not always equally pledgeable or effectively used as collateral. This point is also illustrated in Figure C2 in Appendix C, since *Collateral Slack* remains at relatively high levels during the entire sample period, even though there is some variation across years.

Finally, the mean of *Credit Concentration* is 0.818, while the median is 0.953, and the 75th percentile is equal to 1.000. This indicates that bank borrowing is highly concentrated in the main lender for a substantial share of firm-year observations. This pattern is consistent with the importance of concentrated bank-firm relationships in SME finance, where reliance on a main lender often plays a central role. Figure C3 in Appendix C shows a small increase in *Credit Concentration* over the sample period, suggesting that the role of the main lender remains important for firms with positive bank debt.

3.5. Empirical Specification

3.5.1. Baseline Empirical Specifications

This subsection presents the empirical specifications used to examine the association between *Collateral Slack*, *Credit Concentration*, and subsequent *Net Change in Bank Debt*. The analysis estimates linear panel models with firm and year fixed effects, a standard approach in the capital structure literature to account for persistent firm-specific heterogeneity and common time effects (Antão & Bonfim, 2008; Lemmon et al., 2008). This framework makes it possible to examine whether within-firm variation in *Collateral Slack* and *Credit Concentration* over time is associated with subsequent changes in bank borrowing, after controlling for time-invariant firm-specific heterogeneity and common year effects. For simplicity, the equations below present the variables in compact notation. In the estimations, all variables enter in the form defined in the previous subsection[21].

The baseline specification focuses on the association between *Collateral Slack*, *Credit Concentration*, and *Net Change in Bank Debt*. The corresponding specification is given by:

$$\boldsymbol{NetChangeBankDebt_{i,t}} = \boldsymbol{\beta_0 + \beta_1 CollSlack_{i,t-n} + \beta_2 CreditConc_{i,t-n} + \gamma' X_{i,t-n} + \alpha_i + \lambda_t + \varepsilon_{i,t}} \quad \textbf{Eq. (1)}$$

[21] Detailed information can be found in Appendix B – Research Variables, Table B1.

where $\boldsymbol{X_{i,t-n}}$ denotes the set of control variables, $\boldsymbol{\alpha_i}$ are fixed effects at the firm level, and $\boldsymbol{\lambda_t}$ are year fixed effects. In this specification, $\boldsymbol{\beta_1}$ captures the association between *Collateral Slack* and subsequent *Net Change in Bank Debt*, while $\boldsymbol{\beta_2}$ captures the association between *Credit Concentration* and subsequent *Net Change in Bank Debt.*

The analysis next examines whether *Credit Concentration* modifies the association between *Collateral Slack* and *Net Change in Bank Debt* by estimating the following interaction specification:

$$\begin{aligned}\boldsymbol{NetChangeBankDebt_{i,t}} &= \boldsymbol{\beta_0 + \beta_1 CollSlack_{i,t-n} + \beta_2 CreditConc_{i,t-n}} \\ &+ \boldsymbol{\beta_3 (CollSlack_{i,t-n} \times CreditConc_{i,t-n}) + \gamma' X_{i,t-n} + \alpha_i + \lambda_t + \varepsilon_{i,t}}\end{aligned}$$

Eq. (2)

The interaction term allows the marginal association between *Collateral Slack* and subsequent *Net Change in Bank Debt* to vary with *Credit Concentration.* A positive $\boldsymbol{\beta_3}$ is consistent with the hypothesis that *Collateral Slack* and *Credit Concentration* are complementary in supporting bank borrowing. By contrast, a negative $\boldsymbol{\beta_3}$ is consistent with the view that the two act as substitutes.

The same baseline and interaction specifications are then estimated for the maturity-specific dependent variables, replacing total *Net Change in Bank Debt* with *Short-term and Long-term Net Change in Bank Debt*, respectively.

Although *Collateral Slack* and *Credit Concentration* are both concentrated near the upper bound of their distributions, the panel diagnostics reveal meaningful within-firm variation over time[22]. This is important because the fixed effects estimates are identified from changes within the same firm over time, rather than from differences across firms in the overall cross-sectional distribution. Accordingly, both variables are retained in the empirical specifications.

The fixed effects at the firm level control for time-invariant unobservable firm-specific factors, such as stable differences in management quality, sectoral characteristics, and firms' business models. Meanwhile, the year fixed effects absorb macroeconomic shocks and common changes in credit market conditions. This is especially relevant in the Portuguese context, given that the sample period covers years of credit contraction and subsequent

[22] Detailed information on the within-firm variation of the variables can be found in Appendix C - Supplementary Descriptive Evidence, Table C2.

recovery, and is consistent with prior empirical work on Portuguese firms (Antão & Bonfim, 2008).

The explanatory variables are lagged by one and two years, i.e., $\boldsymbol{n \in \{1, 2\}}$. This choice helps reduce the most immediate simultaneity concerns and is consistent with the idea that debt financing decisions adjust gradually over time rather than instantaneously. Using lagged regressors also helps align the timing of the explanatory variables with the dependent variable, which measures changes in bank debt over the following period. This is economically plausible because both collateral conditions and bank-firm relationships may influence financing outcomes with some delay (Berger & Udell, 1995; Gan, 2007; Petersen & Rajan, 1994)[23].

Although firm and year fixed effects, together with lagged explanatory variables, help to mitigate concerns related to time-invariant unobservable firm heterogeneity, common macroeconomic shocks, and reverse causality, they do not fully eliminate endogeneity concerns.

Finally, the estimations use firm-level clustered standard errors to account for heteroskedasticity across repeated observations of the same firm over time, following common practice in panel-data analysis.

3.5.2. Robustness to the Distribution of Collateral Slack

We also examine whether the baseline results are sensitive to the distributional features of the *Collateral Slack* measure. As shown in the descriptive statistics, *Collateral Slack* is bounded between zero and one and displays a substantial concentration at the upper bound. In this context, the baseline coefficient may combine two different sources of variation: the difference between observations at the upper bound and the variation among observations below that value. This may be relevant because the finance literature suggests that bounded financial variables with mass points can require separate treatment of boundary and interior observations (Cook et al., 2008; Ramalho & da Silva, 2009). Moreover, observations at the boundary may represent a distinct group, rather than simply the upper tail of a continuous distribution (Sardo et al., 2024; Strebulaev & Yang, 2013).

[23] Recent studies also suggest that lending relationships matter for firms' financing choices over time and may reduce the sensitivity of firm outcomes to collateral shocks (Anderson et al., 2023; Geelen et al., 2025).

For this reason, two robustness checks are carried out. The first re-estimates the baseline specification after excluding observations where *Collateral Slack* equals one. This restriction is not intended to define a preferred estimation sample. Instead, it helps assess whether the association between *Collateral Slack* and *Net Change in Bank Debt* is also present within the interior of the distribution, that is, among observations below the upper bound.

The second robustness check keeps all observations in the sample and separates *Collateral Slack* into two terms: an indicator for observations at the upper bound and a continuous measure for observations below one. The purpose of this test is to separate the association linked to observations where *Collateral Slack* is equal to one from the association linked to variation below the upper bound. The logic is similar to distinguishing between boundary and interior observations, rather than imposing the same linear association across both parts of the distribution. This is relevant because, as noted above, observations at the boundary may capture a different empirical pattern from observations within the interior of the distribution (Cook et al., 2008; Ramalho & da Silva, 2009). Although *Collateral Slack* is used here as an explanatory variable rather than as the dependent variable, the same intuition still applies. The estimated specification is therefore given by:

$$\begin{aligned} \boldsymbol{NetChangeBankDebt_{i,t}} \\ &= \boldsymbol{\beta_0 + \beta_1 FullSlack_{i,t-n} + \beta_2 InteriorSlack_{i,t-n} + \beta_3 CreditConc_{i,t-n}} \\ &+ \boldsymbol{\gamma' X_{i,t-n} + \alpha_i + \lambda_t + \varepsilon_{i,t}} \end{aligned}$$

Eq. (3)

where $\boldsymbol{FullSlack_{i,t-n}}$ is an indicator equal to one when *Collateral Slack* equals one, and zero otherwise. $\boldsymbol{InteriorSlack_{i,t-n}}$ is equal to *Collateral Slack* when *Collateral Slack* is below one, and zero otherwise. In this specification, $\boldsymbol{\beta_1}$ captures the discrete association linked to observations at the upper bound, while $\boldsymbol{\beta_2}$ captures the association with variation in *Collateral Slack* within the interior of the distribution.

Taken together, these two exercises make it possible to assess whether the baseline findings are driven only by the contrast between observations with *Collateral Slack* equal to one and all other observations, or whether they also hold across variation in *Collateral Slack* below the upper bound. All robustness specifications are based on the same empirical framework as the baseline model, including firm and year fixed effects as well as lagged regressors and standard errors clustered at the firm level.

4. Findings

This section presents the main empirical findings of the study. Section 4.1 reports the results for the *Overall Net Change in Bank Debt*. Section 4.2 then examines whether the results differ between short-term and long-term bank debt. Finally, Section 4.3 presents the results of the robustness tests. The interpretation of the results is discussed in detail in Section 6.

Given the large number of observations and the use of firm-level clustered standard errors, residual normality is not expected to be a restrictive concern for statistical inference. Multicollinearity is examined through the Pearson correlation matrix, reported in Appendix C - Supplementary Descriptive Evidence, Table C1. The correlations do not suggest severe pairwise collinearity among the variables used in the baseline specifications, although higher collinearity is expected in the specifications that include interaction terms.

4.1. Overall Net Change in Bank Debt Results

Table 2 presents the results for the *Overall Net Change in Bank Debt*. The table reports both the baseline specifications and the interaction specifications between *Collateral Slack* and *Credit Concentration*. The one-year lag specifications are treated as the main timing specification, while the two-year lag specifications provide complementary evidence on whether the estimated associations persist over a longer lag structure. The dependent variable is expressed in percentage points (p.p.).

In the baseline specifications of Table 2, the coefficient of *Collateral Slack* ($\boldsymbol{\beta_1}$) is positive and statistically significant at the 1% level across all regressions. In the main one-year lag specifications, a 10 percentage-point increase in *Collateral Slack* is associated with an increase of approximately 0.56 and 0.60 p.p. in the *Net Change in Bank Debt*, in the models with and without *Financial Pressure*, respectively. This evidence is consistent with Hypothesis 1, according to which higher *Collateral Slack* is positively associated with subsequent net changes in firms' bank debt. The two-year lag specifications provide complementary evidence in the same direction, with positive and statistically significant coefficients, although with smaller magnitudes.

Credit Concentration ($\boldsymbol{\beta_2}$) is also positive and statistically significant across all baseline specifications (p-value < 0.01). In the main one-year lag specifications, increasing *Credit Concentration* by 10 percentage points is associated with an increase in *Net Change in Bank Debt* of approximately 0.96 p.p. when *Financial Pressure* is included, and 1.01 p.p. when it is

excluded. The two-year lag specifications again show a positive and statistically significant association, although the estimated magnitudes are substantially smaller. This evidence is consistent with Hypothesis 2, according to which higher *Credit Concentration* is positively associated with subsequent net changes in firms' bank debt.

Table 2: Overall Net Change in Bank Debt Regression Results

This table reports the results from fixed effects panel regressions, with the *Overall Net Change in Bank Debt* as the dependent variable. The dependent variable is measured as the annual change in bank debt scaled by lagged total assets and expressed in percentage points. Regressions (1), (2), (5), and (6) report the baseline specification presented in Eq. 1, while Regressions (3), (4), (7), and (8) report the interaction specification presented in Eq. 2. Regressions (1) to (4) include *Financial Pressure* as an additional control, while Regressions (5) to (8) exclude this variable. Regressions (1), (3), (5), and (7) use one-year lagged explanatory variables, whereas Regressions (2), (4), (6), and (8) use two-year lagged explanatory variables. All specifications include firm and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.: $NetChangeBankDebt_t$	WITH Financial Pressure				WITHOUT Financial Pressure			
	(1) *t-1*	(2) *t-2*	(3) *t-1*	(4) *t-2*	(5) *t-1*	(6) *t-2*	(7) *t-1*	(8) *t-2*
Collateral Slack	5.568***	3.106***	3.760***	3.312***	5.965***	3.232***	3.940***	3.429***
	(0.140)	(0.150)	(0.421)	(0.443)	(0.133)	(0.143)	(0.402)	(0.426)
Credit Concentration	9.602***	4.849***	7.559***	5.084***	10.055***	5.008***	7.782***	5.231***
	(0.186)	(0.200)	(0.503)	(0.528)	(0.178)	(0.192)	(0.480)	(0.506)
CollSlack x CredConc.			2.368***	-0.273			2.639***	-0.260
			(0.526)	(0.557)			(0.501)	(0.535)
Firm Size	-7.141***	-5.776***	-7.137***	-5.776***	-6.833***	-5.542***	-6.828***	-5.542***
	(0.118)	(0.130)	(0.118)	(0.130)	(0.112)	(0.123)	(0.112)	(0.123)
Firm Age	0.462***	0.384***	0.460***	0.384***	0.404***	0.410***	0.403***	0.410***
	(0.086)	(0.104)	(0.086)	(0.104)	(0.081)	(0.097)	(0.081)	(0.097)
ROA	0.094***	0.030***	0.094***	0.030***	0.121***	0.054***	0.121***	0.054***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.003)	(0.004)	(0.003)	(0.004)
Liquidity	-0.012	-0.360***	-0.012	-0.360***	0.049	-0.321***	0.049	-0.321***
	(0.046)	(0.051)	(0.046)	(0.051)	(0.043)	(0.048)	(0.043)	(0.048)
Financial Pressure	-7.651***	-4.495***	-7.645***	-4.495***				
	(0.173)	(0.191)	(0.173)	(0.191)				
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	481,369	351,770	481,369	351,770	521,673	383,443	521,673	383,443
Within R^2	0.071	0.033	0.071	0.033	0.063	0.029	0.063	0.029
A1	6.107	5.838	6.109	5.838	6.109	5.842	6.111	5.842
A2	9.914	9.615	9.913	9.615	9.946	9.642	9.945	9.642

The coefficient of *Financial Pressure* is negative and statistically significant at the 1% level in the specifications where it is included. This suggests that firms under greater financial pressure experience lower subsequent net increases in bank debt. However, its inclusion does

not materially affect the baseline results, since the coefficients of *Collateral Slack* and *Credit Concentration* remain positive and statistically significant.

Overall, the baseline results in Table 2 show that both *Collateral Slack* and *Credit Concentration* are positively associated with subsequent increases in bank debt. Although the estimated magnitudes are not very large, they remain relevant in the context of annual *Net Change in Bank Debt,* especially for *Credit Concentration*, which shows the larger association in the main one-year specifications. The two-year lag results point in the same direction, although with weaker magnitudes. The common-sample baseline results reported in Appendix D - Supplementary Regression Results, Table D1, show similar signs, significance levels, and magnitudes, suggesting that the differences between the one- and two-year lag specifications are not driven by changes in sample composition.

Regressions (3), (4), (7), and (8) add the interaction term between *Collateral Slack* and *Credit Concentration*. In these specifications, the coefficient of *Collateral Slack* ($\boldsymbol{\beta_1}$) should be interpreted with caution, since the variables are not centered. Therefore, $\boldsymbol{\beta_1}$ captures the association between *Collateral Slack* and subsequent net changes in bank debt when *Credit Concentration* equals zero, and is no longer directly comparable to the baseline coefficient. The interaction term ($\boldsymbol{\beta_3}$) is the coefficient of interest.

In the one-year lag interaction specifications, Regressions (3) and (7), the interaction term ($\boldsymbol{\beta_3}$) is positive and statistically significant at the 1% level. This indicates that, in these specifications, the marginal association between *Collateral Slack* and subsequent net changes in bank debt becomes stronger when *Credit Concentration* is higher. This result does not provide support for Hypothesis 3, which predicted that higher *Credit Concentration* would weaken this association. Instead, for overall bank debt, the one-year lag specifications point to complementarity between *Collateral Slack* and *Credit Concentration*.

By contrast, the interaction term ($\boldsymbol{\beta_3}$) is not statistically significant in the two-year lag specifications, that is, in Regressions (4) and (8). Therefore, the evidence of complementarity appears to be limited to the main one-year lag specifications.

In summary, Table 2 provides evidence consistent with Hypotheses 1 and 2 for overall bank debt in the baseline specifications, as both *Collateral Slack* and *Credit Concentration* are positively associated with subsequent net increases in bank debt. However, the interaction specifications do not provide support for Hypothesis 3. In the one-year lag regressions, the

evidence points to a complementary relationship, rather than a substitution mechanism, between *Collateral Slack* and *Credit Concentration*, while the two-year lag regressions do not show a statistically significant interaction.

4.2. Maturity-Specific Analysis Results

Tables 3 and 4 present the maturity-specific results of the *Net Change in Bank Debt*, separating short-term and long-term debt. As discussed above, this distinction is relevant because debt maturity is an important dimension of firms' financing structure choices (Barclay & Smith, 1995; Diamond, 1991), and because collateral capacity may be more directly related to longer-maturity borrowing, given the role of pledgeable assets in supporting debt capacity (Campello & Giambona, 2013). The interpretation of the interaction terms follows the same logic as in the overall bank debt interaction specifications.

Table 3 presents the results for *Short-Term Net Change in Bank Debt*. The short-term evidence for *Collateral Slack* ($\boldsymbol{\beta_1}$) is weaker than in the overall bank debt regressions. In the baseline specifications, the coefficient of *Collateral Slack* is positive and statistically significant only in the one-year lag specifications, at the 5% level in Regression (9) and at the 1% level in Regression (13), while it is not statistically significant in the two-year lag specifications. This evidence is only partially consistent with Hypothesis 1a. The common-sample baseline results reported in Appendix D, Table D2, reinforce this interpretation, as *Collateral Slack* is no longer statistically significant in the short-term regressions.

By contrast, *Credit Concentration* ($\boldsymbol{\beta_2}$) is positive and statistically significant across all short-term baseline specifications (p-value < 0.01). This is consistent with Hypothesis 2a and indicates that *Credit Concentration* is more consistently associated with *Short-term Net Change in Bank Debt* than *Collateral Slack*.

In the short-term interaction specifications, the interaction term ($\boldsymbol{\beta_3}$) is negative and statistically significant across all interaction specifications, although only at the 10% significance level in the one-year lag specifications, Regressions (11) and (15). This means that the marginal association between *Collateral Slack* and subsequent net changes in short-term bank debt becomes weaker when *Credit Concentration* is higher, which is consistent with Hypothesis 3a. Unlike the overall bank debt interaction results, the short-term specifications therefore provide evidence consistent with the predicted substitution mechanism.

Table 3: Short-Term Net Change in Bank Debt Regression Results

This table reports the results from fixed effects panel regressions, with the *Short-Term Net Change in Bank Debt* as the dependent variable. Short-term bank debt is defined as credit with an original maturity up to one year, using the maturity-specific credit exposures available in the CRC. The dependent variable is measured as the annual change in short-term bank debt scaled by lagged total assets and expressed in percentage points. Regressions (9), (10), (13), and (14) report the baseline specification presented in Eq. 1, while Regressions (11), (12), (15), and (16) report the interaction specification presented in Eq. 2. Regressions (9) to (12) include *Financial Pressure* as an additional control, while Regressions (13) to (16) exclude this variable. Regressions (9), (11), (13), and (15) use one-year lagged explanatory variables, whereas Regressions (10), (12), (14), and (16) use two-year lagged explanatory variables. All specifications include firm and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.: $NetChangeBankDebt\_ST_t$	WITH Financial Pressure				WITHOUT Financial Pressure			
	(9) *t-1*	(10) *t-2*	(11) *t-1*	(12) *t-2*	(13) *t-1*	(14) *t-2*	(15) *t-1*	(16) *t-2*
Collateral Slack	0.157**	-0.052	0.524**	0.421	0.291***	0.021	0.665***	0.393
	(0.070)	(0.079)	(0.237)	(0.256)	(0.067)	(0.076)	(0.228)	(0.246)
Credit Concentration	3.338***	1.487***	3.752***	2.028***	3.559***	1.512***	3.979***	1.935***
	(0.095)	(0.106)	(0.264)	(0.288)	(0.091)	(0.102)	(0.254)	(0.276)
CollSlack x CredConc.			-0.481*	-0.628**			-0.487*	-0.491*
			(0.282)	(0.308)			(0.270)	(0.295)
Firm Size	-1.437***	-1.143***	-1.437***	-1.144***	-1.424***	-1.139***	-1.425***	-1.140***
	(0.052)	(0.062)	(0.052)	(0.062)	(0.049)	(0.058)	(0.049)	(0.058)
Firm Age	0.018	0.026	0.018	0.026	0.009	0.047	0.009	0.047
	(0.043)	(0.061)	(0.043)	(0.061)	(0.040)	(0.056)	(0.040)	(0.056)
ROA	0.016***	0.003	0.016***	0.003	0.029***	0.008***	0.029***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Liquidity	0.938***	0.403***	0.938***	0.403***	0.924***	0.394***	0.924***	0.394***
	(0.022)	(0.024)	(0.022)	(0.024)	(0.021)	(0.023)	(0.021)	(0.023)
Financial Pressure	-2.902***	-1.169***	-2.903***	-1.171***				
	(0.104)	(0.115)	(0.104)	(0.115)				
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	481,369	351,770	481,369	351,770	521,673	383,443	521,673	383,443
Within R^2	0.025	0.010	0.025	0.010	0.022	0.009	0.022	0.009
A1	2.992	2.835	2.991	2.835	3.019	2.864	3.019	2.864
A2	5.374	5.201	5.374	5.201	5.421	5.250	5.421	5.250

Table 4 presents the results for *Long-Term Net Change in Bank Debt*. *Collateral Slack* ($\boldsymbol{\beta_1}$) is positive and statistically significant at the 1% level across all long-term baseline specifications, which is consistent with Hypothesis 1b. This contrasts with the short-term results and suggests that the positive association between *Collateral Slack* and *Net Change in Bank Debt* is stronger and more consistent in the long-term specifications. The common-sample baseline results reported in Appendix D, Table D3, lead to the same conclusion.

Table 4: Long-Term Net Change in Bank Debt Regression Results

This table reports the results from fixed effects panel regressions, with the *Long-Term Net Change in Bank Debt* as the dependent variable. Long-term bank debt is defined as credit with an original maturity above one year, using the maturity-specific credit exposures available in the CRC. The dependent variable is measured as the annual change in long-term bank debt scaled by lagged total assets and expressed in percentage points. Regressions (17), (18), (21), and (22) report the baseline specification presented in Eq. 1, while Regressions (19), (20), (23), and (24) report the interaction specification presented in Eq. 2. Regressions (17) to (20) include *Financial Pressure* as an additional control, while Regressions (21) to (24) exclude this variable. Regressions (17), (19), (21), and (23) use one-year lagged explanatory variables, whereas Regressions (18), (20), (22), and (24) use two-year lagged explanatory variables. All specifications include firm and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.: $NetChangeBankDebt\_LT_t$	WITH Financial Pressure				WITHOUT Financial Pressure			
	(17) *t-1*	(18) *t-2*	(19) *t-1*	(20) *t-2*	(21) *t-1*	(22) *t-2*	(23) *t-1*	(24) *t-2*
Collateral Slack	5.265***	3.112***	3.453***	2.920***	5.509***	3.168***	3.468***	3.072***
	(0.127)	(0.135)	(0.375)	(0.394)	(0.121)	(0.128)	(0.356)	(0.378)
Credit Concentration	6.301***	3.363***	4.255***	3.144***	6.505***	3.502***	4.213***	3.393***
	(0.167)	(0.177)	(0.453)	(0.474)	(0.159)	(0.169)	(0.430)	(0.453)
CollSlack x CredConc.			2.373***	0.255			2.661***	0.126
			(0.473)	(0.501)			(0.449)	(0.478)
Firm Size	-5.159***	-4.334***	-5.154***	-4.334***	-4.860***	-4.122***	-4.855***	-4.121***
	(0.103)	(0.113)	(0.103)	(0.113)	(0.097)	(0.107)	(0.097)	(0.107)
Firm Age	0.442***	0.354***	0.440***	0.354***	0.396***	0.359***	0.395***	0.359***
	(0.076)	(0.099)	(0.076)	(0.099)	(0.072)	(0.091)	(0.072)	(0.091)
ROA	0.074***	0.028***	0.074***	0.028***	0.087***	0.044***	0.087***	0.044***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
Liquidity	-1.041***	-0.824***	-1.041***	-0.824***	-0.965***	-0.771***	-0.965***	-0.771***
	(0.044)	(0.049)	(0.044)	(0.049)	(0.041)	(0.045)	(0.041)	(0.045)
Financial Pressure	-4.518***	-3.244***	-4.512***	-3.244***				
	(0.158)	(0.177)	(0.158)	(0.177)				
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	481,369	351,770	481,369	351,770	521,673	383,443	521,673	383,443
Within R^2	0.049	0.024	0.049	0.024	0.044	0.021	0.044	0.021
A1	5.449	5.222	5.450	5.222	5.441	5.227	5.443	5.227
A2	9.040	8.760	9.039	8.760	9.057	8.787	9.057	8.787

The coefficient of *Credit Concentration* ($\boldsymbol{\beta_2}$) is also positive and statistically significant across all long-term baseline specifications (p-value < 0.01), which is consistent with Hypothesis 2b. Unlike *Collateral Slack*, *Credit Concentration* is positively associated with both short-term and long-term bank debt changes, although the estimated association is stronger for *Long-Term Net Change in Bank Debt*.

In the long-term interaction specifications, the interaction term ($\boldsymbol{\beta_3}$) is positive and statistically significant at the 1% level only in the one-year lag specifications, Regressions (19) and (23), while it is not statistically significant in the two-year lag specifications, Regressions (20) and (24). This means that, in the main one-year lag specifications, the marginal association between *Collateral Slack* and subsequent net changes in long-term bank debt becomes stronger when *Credit Concentration* is higher. This pattern resembles the overall bank debt results, but contrasts with the short-term results, where the interaction term is negative and statistically significant. Therefore, the evidence does not provide support for Hypothesis 3b.

The maturity-specific results therefore suggest that the positive association between *Collateral Slack* and *Net Change in Bank Debt* is stronger in long-term specifications. This indicates that *Collateral Slack* appears to be more relevant for longer-maturity borrowing, while the short-term evidence is more limited. *Credit Concentration* is positively associated with both short-term and long-term bank debt changes. Finally, the interaction specifications differ across maturities, as the short-term regressions are consistent with the predicted substitution mechanism, while the one-year long-term regressions suggest complementarity.

4.3. Robustness Check Results

This section presents two robustness checks related to the distribution of *Collateral Slack*. As shown in the descriptive statistics, *Collateral Slack* is bounded between zero and one and has a strong concentration at the upper bound. This may matter because observations with *Collateral Slack* equal to one may represent a specific group of firm-year observations, rather than simply the upper tail of the distribution (Cook et al., 2008; Ramalho & da Silva, 2009; Sardo et al., 2024; Strebulaev & Yang, 2013). To keep the analysis concise, the robustness checks are reported only with *Financial Pressure* included, as this corresponds to the richer control specification.

4.3.1. Exclusion of Full-Slack Observations

Table 5 reports the first robustness check, excluding observations where *Collateral Slack* equals one. The results are broadly in line with the baseline conclusions. *Collateral Slack* ($\boldsymbol{\beta_1}$) remains positive and statistically significant at the 1% level for overall and long-term bank debt in both lag specifications. In the short-term regressions, it remains significant (p-value < 0.01) only in the one-year lag specification. This reinforces the maturity pattern

documented in Section 4.2, where the association between *Collateral Slack* and *Net Change in Bank Debt* is stronger and more consistent in the overall and long-term regressions.

Credit Concentration ($\boldsymbol{\beta_2}$) remains positive and statistically significant at the 1% level across all regressions, indicating that its association with subsequent net changes in bank debt is robust to the exclusion of full-slack observations.

Table 5: Baseline Regression Results Excluding Full-Slack Observations

This table reports the results from fixed effects panel regressions after excluding firm-year observations for which *Collateral Slack* equals one. The dependent variables are the overall, short-term, and long-term net changes in bank debt, calculated as annual changes in total, short-term, and long-term bank debt, respectively, scaled by lagged total assets and expressed in percentage points. All regressions follow the baseline specification presented in Eq. 1. Regressions (25) and (26) use the *Overall Net Change in Bank Debt* as the dependent variable, Regressions (27) and (28) use the *Short-Term Net Change in Bank Debt,* and Regressions (29) and (30) use the *Long-Term Net Change in Bank Debt*. Regressions (25), (27), and (29) use one-year lagged explanatory variables, while Regressions (26), (28), and (30) use two-year lagged explanatory variables. All regressions include *Financial Pressure* as an additional control, as well as firm and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.:	$NetChangeBankDebt_t$		$NetChangeBankDebt\_ST_t$		$NetChangeBankDebt\_LT_t$	
	(25) *t-1*	(26) *t-2*	(27) *t-1*	(28) *t-2*	(29) *t-1*	(30) *t-2*
Collateral Slack	6.341***	3.630***	1.019***	0.078	5.161***	3.444***
	(0.276)	(0.280)	(0.138)	(0.154)	(0.249)	(0.252)
Credit Concentration	8.399***	4.498***	3.490***	1.794***	5.098***	2.680***
	(0.398)	(0.414)	(0.198)	(0.216)	(0.359)	(0.371)
Firm Size	-8.268***	-7.050***	-1.605***	-1.433***	-6.297***	-5.312***
	(0.265)	(0.270)	(0.117)	(0.133)	(0.231)	(0.232)
Firm Age	0.401***	0.411**	0.053	0.026	0.322**	0.365**
	(0.153)	(0.173)	(0.078)	(0.108)	(0.145)	(0.173)
ROA	0.117***	0.053***	0.025***	0.004	0.090***	0.048***
	(0.010)	(0.011)	(0.004)	(0.005)	(0.009)	(0.010)
Liquidity	0.281***	-0.050	0.987***	0.421***	-0.758***	-0.523***
	(0.074)	(0.080)	(0.036)	(0.038)	(0.071)	(0.075)
Financial Pressure	-4.721***	-2.991***	-2.030***	-0.699***	-2.541***	-2.269***
	(0.263)	(0.282)	(0.159)	(0.171)	(0.243)	(0.263)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	153,092	118,514	153,092	118,514	153,092	118,514
Within R^2	0.061	0.033	0.024	0.009	0.041	0.024
A1	5.364	5.138	2.827	2.662	4.848	4.635
A2	8.882	8.626	5.039	4.882	8.150	7.868

The corresponding interaction specifications are reported in Table 6 and follow the same logic as in the previous interaction specifications. After excluding full-slack observations, the

interaction term is no longer statistically significant for overall or long-term bank debt. For short-term, it remains negative and significant at the 1% level in the one-year lag specification. Therefore, this robustness check is consistent with the baseline associations underlying Hypotheses 1 and 2, but suggests that the interaction results related to Hypothesis 3 are more sensitive to the exclusion of full-slack observations.

Table 6: Interaction Results Excluding Full-Slack Observations

This table reports the interaction specification after excluding firm-year observations for which *Collateral Slack* equals one. The dependent variables are the overall, short-term, and long-term net changes in bank debt, calculated as annual changes in total, short-term, and long-term bank debt, respectively, scaled by lagged total assets and expressed in percentage points. Regressions (31) and (32) use the *Overall Net Change in Bank Debt* as the dependent variable, Regressions (33) and (34) use the *Short-Term Net Change in Bank Debt,* and Regressions (35) and (36) use the *Long-Term Net Change in Bank Debt*. Regressions (31), (33), and (35) use one-year lagged explanatory variables, while Regressions (32), (34), and (36) use two-year lagged explanatory variables. All regressions follow the interaction specification presented in Eq. 2 and include *Financial Pressure*, firm fixed effects, and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.:	$NetChangeBankDebt_t$		$NetChangeBankDebt\_ST_t$		$NetChangeBankDebt\_LT_t$	
	(31) *t-1*	(32) *t-2*	(33) *t-1*	(34) *t-2*	(35) *t-1*	(36) *t-2*
Collateral Slack	6.489***	3.554***	2.141***	0.495	4.476***	2.895***
	(0.669)	(0.693)	(0.373)	(0.408)	(0.595)	(0.615)
Credit Concentration	8.514***	4.438***	4.358***	2.122***	4.568***	2.247***
	(0.667)	(0.681)	(0.351)	(0.382)	(0.597)	(0.612)
CollSlack x CredConc.	-0.209	0.108	-1.583***	-0.594	0.966	0.784
	(0.883)	(0.911)	(0.465)	(0.513)	(0.791)	(0.816)
Firm Size	-8.267***	-7.050***	-1.601***	-1.430***	-6.300***	-5.317***
	(0.266)	(0.270)	(0.117)	(0.133)	(0.231)	(0.232)
Firm Age	0.401***	0.411**	0.054	0.028	0.321**	0.363**
	(0.153)	(0.173)	(0.077)	(0.108)	(0.146)	(0.173)
ROA	0.117***	0.053***	0.025***	0.004	0.090***	0.048***
	(0.010)	(0.011)	(0.004)	(0.005)	(0.009)	(0.010)
Liquidity	0.281***	-0.050	0.983***	0.419***	-0.756***	-0.520***
	(0.074)	(0.080)	(0.036)	(0.038)	(0.071)	(0.075)
Financial Pressure	-4.722***	-2.990***	-2.037***	-0.702***	-2.536***	-2.266***
	(0.263)	(0.282)	(0.159)	(0.171)	(0.243)	(0.263)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	153,092	118,514	153,092	118,514	153,092	118,514
Within R^2	0.061	0.033	0.024	0.009	0.041	0.024
A1	5.364	5.138	2.826	2.662	4.849	4.636
A2	8.882	8.626	5.038	4.882	8.150	7.868

4.3.2. Full-Slack and Interior-Slack Specification

Table 7 presents the second robustness check, which distinguishes between observations located at the upper bound of the *Collateral Slack* distribution and variation within the interior of the distribution, as defined in Section 3.5.2.

Table 7: Full and Interior Slack Regression Results

This table reports the results from fixed effects panel regressions using the specification presented in Eq. 3. The baseline *Collateral Slack* variable is replaced by two terms: *Full Slack*, an indicator equal to one when *Collateral Slack* equals one, and *Interior Slack*, which captures collateral slack variation below the upper bound. The dependent variables are the overall, short-term, and long-term net changes in bank debt, calculated as annual changes in total, short-term, and long-term bank debt, respectively, scaled by lagged total assets and expressed in percentage points. Regressions (37) and (38) use the *Overall Net Change in Bank Debt* as the dependent variable, Regressions (39) and (40) use the *Short-Term Net Change in Bank Debt,* and Regressions (41) and (42) use the *Long-Term Net Change in Bank Debt.* Regressions (37), (39), and (41) use one-year lagged explanatory variables, while Regressions (38), (40), and (42) use two-year lagged explanatory variables. All regressions include *Financial Pressure*, firm fixed effects, and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.:	$NetChangeBankDebt_t$		$NetChangeBankDebt\_ST_t$		$NetChangeBankDebt\_LT_t$	
	(37) *t-1*	(38) *t-2*	(39) *t-1*	(40) *t-2*	(41) *t-1*	(42) *t-2*
Full Slack	5.548***	3.101***	0.187***	-0.049	5.211***	3.100***
	(0.140)	(0.151)	(0.070)	(0.080)	(0.128)	(0.135)
Interior Slack	5.291***	3.023***	0.578***	-0.005	4.514***	2.937***
	(0.181)	(0.195)	(0.092)	(0.105)	(0.164)	(0.175)
Credit Concentration	9.550***	4.833***	3.416***	1.496***	6.161***	3.331***
	(0.187)	(0.201)	(0.096)	(0.107)	(0.168)	(0.178)
Firm Size	-7.129***	-5.772***	-1.454***	-1.145***	-5.128***	-4.326***
	(0.118)	(0.130)	(0.052)	(0.062)	(0.103)	(0.113)
Firm Age	0.461***	0.384***	0.018	0.026	0.441***	0.354***
	(0.086)	(0.104)	(0.043)	(0.061)	(0.076)	(0.099)
ROA	0.094***	0.030***	0.016***	0.003	0.074***	0.028***
	(0.004)	(0.005)	(0.002)	(0.002)	(0.004)	(0.005)
Liquidity	-0.016	-0.361***	0.944***	0.404***	-1.052***	-0.827***
	(0.046)	(0.051)	(0.022)	(0.024)	(0.044)	(0.049)
Financial Pressure	-7.655***	-4.496***	-2.895***	-1.169***	-4.530***	-3.247***
	(0.173)	(0.191)	(0.104)	(0.115)	(0.158)	(0.177)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	481,369	351,770	481,369	351,770	481,369	351,770
Within R^2	0.071	0.033	0.025	0.010	0.049	0.024
A1	6.107	5.838	2.992	2.835	5.448	5.222
A2	9.914	9.615	5.373	5.201	9.039	8.760

The results show that *Full Slack* and *Interior Slack* are both positive and statistically significant at the 1% level for *Overall and Long-Term Net Change in Bank Debt*, in both lag specifications.

This suggests that the baseline result is not explained only by firms with *Collateral Slack* equal to one, since the interior part of the distribution also remains positively associated with subsequent bank debt changes.

The short-term results remain weaker. *Full Slack* and *Interior Slack* are positive and statistically significant (p-value < 0.01) only in the one-year lag specification, while they are not statistically significant in the two-year lag specifications. This is in line with the maturity-specific analysis in Section 4.2, where the results were stronger for long-term bank debt.

Credit Concentration remains positive and statistically significant at the 1% level across all regressions, suggesting that this result is not sensitive to the way *Collateral Slack* is treated.

Table 8 shows that the interaction results are less stable than the baseline associations. For overall and long-term bank debt, the positive interaction terms are mainly linked to the *Full Slack* component and only appear in the one-year lag specifications, while the *Interior Slack* interactions are not statistically significant. For short-term debt, the interaction terms are mostly negative, with stronger evidence in the one-year lag specification.

Taken together, Tables 5 to 8 show that the main results for *Collateral Slack* are not driven only by full-slack observations. The evidence for Hypotheses 1 and 2 remains broadly robust. By contrast, the evidence for Hypothesis 3 is more sensitive to how the upper-bound observations are treated. The short-term substitution pattern is the most persistent interaction result, while the overall and long-term complementarity patterns are mainly linked to full-slack observations in the one-year lag specifications.

Table 8: Full and Interior Slack Interaction Results

This table reports the results from fixed effects panel regressions extending the specification presented in Eq. 3 by adding interaction terms between *Credit Concentration* and the two *Collateral Slack* components. *Full Slack* is an indicator equal to one when *Collateral Slack* equals one, while *Interior Slack* captures collateral slack variation below the upper bound. The interactions *Full Slack* × *Credit Concentration* and *Interior Slack* × *Credit Concentration* allow the moderating role of *Credit Concentration* to differ between observations at the upper bound and observations within the interior of the *Collateral Slack* distribution. The dependent variables are the overall, short-term, and long-term net changes in bank debt, calculated as annual changes in total, short-term, and long-term bank debt, respectively, scaled by lagged total assets and expressed in percentage points. Regressions (43) and (44) use the *Overall Net Change in Bank Debt* as the dependent variable, Regressions (45) and (46) use the *Short-Term Net Change in Bank Debt,* and Regressions (47) and (48) use the *Long-Term Net Change in Bank Debt.* Regressions (43), (45), and (47) use one-year lagged explanatory variables, while Regressions (44), (46), and (48) use two-year lagged explanatory variables. All regressions include *Financial Pressure*, firm fixed effects, and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.:	$NetChangeBankDebt_t$		$NetChangeBankDebt\_ST_t$		$NetChangeBankDebt\_LT_t$	
	(43) *t-1*	(44) *t-2*	(45) *t-1*	(46) *t-2*	(47) *t-1*	(48) *t-2*
Full Slack	3.972***	3.304***	0.591**	0.414	3.591***	2.915***
	(0.423)	(0.445)	(0.239)	(0.258)	(0.377)	(0.395)
Interior Slack	5.526***	3.181***	1.391***	0.386	4.255***	2.743***
	(0.536)	(0.565)	(0.301)	(0.328)	(0.477)	(0.502)
Credit Concentration	8.246***	5.054***	3.981***	2.005***	4.689***	3.117***
	(0.520)	(0.545)	(0.276)	(0.300)	(0.468)	(0.489)
FullSlack x CredConc.	2.014***	-0.269	-0.541*	-0.612**	2.084***	0.247
	(0.530)	(0.561)	(0.285)	(0.311)	(0.478)	(0.504)
IntSlack x CredConc.	-0.603	-0.204	-1.135***	-0.509	0.120	0.259
	(0.698)	(0.739)	(0.372)	(0.410)	(0.627)	(0.665)
Firm Size	-7.123***	-5.773***	-1.454***	-1.146***	-5.122***	-4.326***
	(0.118)	(0.130)	(0.052)	(0.062)	(0.103)	(0.113)
Firm Age	0.460***	0.384***	0.018	0.026	0.440***	0.354***
	(0.086)	(0.104)	(0.043)	(0.061)	(0.076)	(0.099)
ROA	0.094***	0.030***	0.016***	0.003	0.074***	0.028***
	(0.004)	(0.005)	(0.002)	(0.002)	(0.004)	(0.005)
Liquidity	-0.022	-0.361***	0.943***	0.404***	-1.056***	-0.827***
	(0.046)	(0.051)	(0.022)	(0.024)	(0.044)	(0.049)
Financial Pressure	-7.652***	-4.497***	-2.897***	-1.170***	-4.526***	-3.246***
	(0.173)	(0.191)	(0.104)	(0.115)	(0.158)	(0.177)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	481,369	351,770	481,369	351,770	481,369	351,770
Within R^2	0.071	0.033	0.025	0.010	0.049	0.024
A1	6.108	5.838	2.992	2.835	5.449	5.222
A2	9.913	9.615	5.373	5.201	9.038	8.760

5. Additional Analysis

As an additional analysis, the baseline framework is extended to incorporate other forms of contractual credit support, which can influence borrowing capacity beyond what is captured by the *Collateral Slack* proxy. For instance, credit agreements in SME lending may also rely on personal and institutional or public guarantees, which can improve lenders' recovery prospects through mechanisms different from asset-based collateral.

Personal guarantees expand the creditor's claims from the assets of the firm to the personal wealth of the owner. These guarantees are often used when firms are more opaque or when there is limited collateral at the firm level (Avery et al., 1998; Ono & Uesugi, 2009). By contrast, institutional or public guarantees are provided through third-party risk-sharing mechanisms that may ease firms' financing constraints by reducing expected losses for creditors and expanding access to debt finance (Beck et al., 2010; Lelarge et al., 2010; Zecchini & Ventura, 2009)[24].

This extension examines whether the association between *Collateral Slack* and subsequent net changes in bank debt remains similar after accounting for these additional guarantee mechanisms. The aim is not to modify the core framework of the dissertation, but rather to assess whether the relationship between the *Collateral Slack* proxy and bank borrowing remains after accounting for them.

Accordingly, the baseline specification is augmented as follows[25]:

$$\begin{aligned} \boldsymbol{NetChangeBankDebt_{i,t}} \\ &= \boldsymbol{\beta_0 + \beta_1 CollSlack_{i,t-n} + \beta_2 CreditConc_{i,t-n} + \beta_3 PG_{i,t-n} + \beta_4 IG_{i,t-n}} \\ &+ \boldsymbol{\gamma' X_{i,t-n} + \alpha_i + \lambda_t + \varepsilon_{i,t}} \end{aligned}$$

Eq. (4)

where $\boldsymbol{PG_{i,t-n}}$ is a dummy variable that takes the value of one if the firm has outstanding loans supported by personal guarantees, and $\boldsymbol{IG_{i,t-n}}$ is a dummy variable that is equal to one if the firm has institutional or public guarantees.

Both variables are defined at the firm-year level and are lagged consistently with the main explanatory variables. The same extension is applied to the maturity-specific regressions for

[24] Public guarantee schemes are not homogeneous across countries. Beck et al. (2010) document substantial variation in the design of partial credit guarantee schemes, while Lelarge et al. (2010) and Zecchini and Ventura (2009) study specific national guarantee programmes in France and Italy, respectively.

[25] Detailed information on variable construction and the Pearson correlation matrix for this additional analysis can be found in Appendix E - Additional Contractual Credit Support Results, Table E1 and Table E2.

short-term and long-term net changes in bank debt, and to the specifications that include the interaction between *Collateral Slack* and *Credit Concentration*.

This augmented specification makes it possible to distinguish between borrowing associated with the proxy for unused asset-based collateral capacity and borrowing associated with other types of contractual credit enhancements. While *Collateral Slack* proxies the share of business tangible assets that are not matched by borrowing secured by real collateral, personal and institutional guarantees may enhance borrowing capacity through other contractual enforcement or risk-sharing mechanisms.

Table 9 reports the augmented versions of the baseline specifications with *Financial Pressure* included, which adds *Personal Guarantees* and *Institutional Guarantees* as additional forms of contractual credit support.

The results show that adding *Personal Guarantees* and *Institutional Guarantees* does not change the main conclusions. *Collateral Slack* remains positive and statistically significant at the 1% level for *Overall and Long-Term Net Change in Bank Debt* across both lag specifications. However, it is not statistically significant in the short-term regressions, reinforcing the previous evidence that *Collateral Slack* is more consistently associated with long-term bank debt changes.

Credit Concentration also remains positive and statistically significant (p-value < 0.01) across all regressions. Although its coefficients are smaller than in the baseline specifications for overall and long-term bank debt, they remain positive and statistically significant. This suggests that the result for *Credit Concentration* is not explained by the inclusion of additional contractual credit support variables.

Regarding the additional guarantee variables, the coefficients on *Personal Guarantees* are negative and statistically significant at the 1% level across all regressions. The coefficients on *Institutional Guarantees* are also negative and statistically significant (p-value < 0.01) for *Overall and Long-Term Net Change in Bank Debt*, but positive and statistically significant at the 1% level in the short-term regressions.

The corresponding interaction specifications, reported in Appendix E - Additional Contractual Credit Support Results, Table E3, show results broadly similar to those reported in Sections 4.1 and 4.2 after including *Personal Guarantees* and *Institutional Guarantees*. Following the same logic as in the previous interaction specifications, the interaction term remains

positive and statistically significant for overall and long-term bank debt only in the one-year lag specifications. In the short-term regressions, however, the interaction term remains negative and statistically significant. Therefore, these additional specifications reinforce the previous interpretation, as the substitution pattern continues to appear only for short-term bank debt.

Table 9: Additional Contractual Credit Support Regression Results

This table reports the results from fixed effects panel regressions using the specification presented in Eq. 4. The dependent variables are the overall, short-term, and long-term net changes in bank debt, calculated as annual changes in total, short-term, and long-term bank debt, respectively, scaled by lagged total assets and expressed in percentage points. Regressions (49) and (50) use the *Overall Net Change in Bank Debt* as the dependent variable, Regressions (51) and (52) use the *Short-Term Net Change in Bank Debt*, and Regressions (53) and (54) use the *Long-Term Net Change in Bank Debt*. Regressions (49), (51), and (53) use one-year lagged explanatory variables, while Regressions (50), (52), and (54) use two-year lagged explanatory variables. All regressions include *Personal Guarantees, Institutional Guarantees, Financial Pressure*, firm fixed effects, and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.:	$NetChangeBankDebt_t$		$NetChangeBankDebt\_ST_t$		$NetChangeBankDebt\_LT_t$	
	(49) *t-1*	(50) *t-2*	(51) *t-1*	(52) *t-2*	(53) *t-1*	(54) *t-2*
Collateral Slack	5.702***	3.136***	0.087	-0.065	5.471***	3.156***
	(0.139)	(0.150)	(0.070)	(0.079)	(0.127)	(0.135)
Credit Concentration	7.774***	4.113***	3.285***	1.429***	4.544***	2.771***
	(0.189)	(0.203)	(0.097)	(0.108)	(0.169)	(0.180)
Personal Guarantees	-2.940***	-0.998***	-0.649***	-0.265***	-2.228***	-0.682***
	(0.081)	(0.088)	(0.037)	(0.042)	(0.073)	(0.079)
Institutional Guarantees	-2.369***	-1.337***	0.643***	0.127***	-3.029***	-1.440***
	(0.070)	(0.078)	(0.036)	(0.042)	(0.064)	(0.071)
Firm Size	-6.620***	-5.537***	-1.459***	-1.134***	-4.619***	-4.111***
	(0.118)	(0.130)	(0.052)	(0.062)	(0.103)	(0.113)
Firm Age	0.474***	0.395***	0.018	0.027	0.454***	0.364***
	(0.087)	(0.103)	(0.043)	(0.061)	(0.077)	(0.099)
ROA	0.092***	0.029***	0.017***	0.003	0.072***	0.027***
	(0.004)	(0.005)	(0.002)	(0.002)	(0.004)	(0.004)
Liquidity	0.034	-0.333***	0.925***	0.401***	-0.981***	-0.795***
	(0.045)	(0.051)	(0.022)	(0.024)	(0.043)	(0.049)
Financial Pressure	-7.071***	-4.273***	-2.921***	-1.162***	-3.923***	-3.037***
	(0.172)	(0.191)	(0.105)	(0.115)	(0.157)	(0.177)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	481,369	351,770	481,369	351,770	481,369	351,770
Within R^2	0.079	0.034	0.026	0.010	0.059	0.026
A1	6.083	5.832	2.997	2.837	5.418	5.213
A2	9.868	9.606	5.370	5.201	8.988	8.751

6. Discussion

The findings of this dissertation suggest that *Collateral Slack* and *Credit Concentration* are both associated with subsequent changes in SME bank debt. *Collateral Slack* is mainly associated with long-term bank debt, while *Credit Concentration* remains relevant for both short-term and long-term borrowing. This distinction is important because collateral and bank relationship structure are often treated as mechanisms that reduce SME financing frictions (Berger & Udell, 1995; Boot, 2000). The evidence in this dissertation suggests a more specific interpretation: both mechanisms are relevant, but not in the same way across debt maturities.

The results obtained for *Collateral Slack* are consistent with the collateral channel literature. Firms with higher *Collateral Slack* are associated with larger subsequent increases in bank debt, especially long-term bank debt. This is in line with the idea that collateral can improve lenders' recovery prospects in case of default, increase pledgeable income, and reduce repayment problems (Boot et al., 1991; Hart & Moore, 1994; Holmström & Tirole, 1997; Rampini & Viswanathan, 2010). However, the evidence does not simply show that firms with more tangible assets borrow more. Instead, it suggests that what also matters is whether part of these assets appears not to be already linked to bank credit secured by real collateral.

This distinction is relevant because most studies in the capital structure literature use tangibility and real estate values as proxies for collateral capacity. In general, this literature suggests that firms with more pledgeable assets tend to have greater borrowing capacity and, in some cases, higher investment (Chaney et al., 2012; Cvijanović, 2014; Frank & Goyal, 2009; Rajan & Zingales, 1995). By contrast, *Collateral Slack* captures a different margin, since it considers the unused part of the firm's PPE-based collateral base after accounting for bank credit secured by real collateral. This is consistent with Campello and Giambona (2013), who show that asset pledgeability adds information that is not captured by traditional tangibility measures, and with Norden and van Kampen (2013), who show that different asset classes contribute differently to the collateral channel.

The analysis by debt maturity helps to clarify this point. If *Collateral Slack* were only capturing a general borrowing-capacity effect, one might expect the results to appear more similar across short-term and long-term debt. Instead, the evidence is stronger for long-term bank debt. This result is plausible because longer-maturity credit exposes banks to more uncertainty about the future condition and the repayment capacity of the borrower. In that

context, unused collateral capacity may become more relevant, as it gives the bank additional protection over a longer horizon. This is consistent with the debt maturity literature, where borrower risk, information problems, asset structure, and collateral quality are related to longer-maturity debt financing (Barclay & Smith, 1995; Diamond, 1991; Flannery, 1986). The weaker short-term evidence should therefore not be interpreted as meaning that collateral is irrelevant. It suggests instead that short-term borrowing may be more connected to liquidity needs, working capital, or refinancing, while unused collateral capacity is more relevant for longer-term bank financing.

Regarding *Credit Concentration*, the evidence is consistent with the relevance of bank relationship structure for SME bank debt adjustments. Unlike *Collateral Slack*, *Credit Concentration* is positively associated with both short-term and long-term bank debt changes. This means that firms whose bank credit is more concentrated in the main lender tend to show more positive subsequent changes in bank debt. This result is in line with studies suggesting that the concentration of debt in a main lender may affect firms' borrowing outcomes, particularly for smaller firms and SMEs (Angori et al., 2019; Cenni et al., 2015). Therefore, this result points to the relevance of lender dependence for subsequent debt changes, rather than to the informational depth of the bank-firm relationship.

At the same time, this interpretation should remain cautious. Higher *Credit Concentration* does not necessarily imply better financing conditions overall, since dependence on a main lender may also reduce outside options and expose firms to hold-up problems, switching costs, or other costs associated with more concentrated banking relationships (Farinha & Santos, 2002; Greenbaum et al., 1989; Ornelas et al., 2022; Rajan, 1992; Sharpe, 1990). Therefore, the results should be interpreted as evidence on subsequent bank debt changes, rather than on borrowing costs or other contractual conditions.

The interaction between *Collateral Slack* and *Credit Concentration* is less clear. We expected a substitution mechanism, according to which the association between *Collateral Slack* and subsequent bank debt changes would be weaker when *Credit Concentration* is higher. The results are only partially consistent with this view, since evidence consistent with substitution appears only in the short-term regressions. This suggests that, for short-term bank debt, unused collateral capacity is less strongly associated with subsequent debt changes when bank credit is more concentrated in the main lender. These results are consistent with the broader idea that collateral may become less central when firms' reliance on the main lender plays a

more important role in lending decisions (Anderson et al., 2023; Berger & Udell, 1995; Boot, 2000). However, in the present dissertation, this evidence should be interpreted as showing that the role of unused collateral capacity differs when lender dependence is higher, without identifying the mechanism behind this association.

By contrast, the overall and long-term debt results suggest a different interpretation. In these regressions, especially in the one-year lag specifications, the evidence is more consistent with a complementarity mechanism, where *Collateral Slack* and *Credit Concentration* appear to be jointly associated with more positive bank debt changes. This suggests that, for overall and long-term bank debt, unused collateral capacity remains relevant when bank credit is more concentrated in the main lender. This interpretation is consistent with studies showing that collateral may remain relevant in SME lending even when firms have stronger or more central bank-firm relationships (Fanta, 2016; Ono & Uesugi, 2009). Therefore, the evidence does not support a general substitution effect. Instead, it suggests that the interaction between collateral capacity and bank relationship structure depends on debt maturity.

The robustness checks also point to a cautious interpretation. *Collateral Slack* and *Credit Concentration* remain broadly stable across the additional specifications, suggesting that the main findings are not driven only by full-slack observations. However, the interaction results are more sensitive across specifications. This may be because the interaction effects are mainly observed among firms with full collateral slack. After excluding these observations, the interaction results for overall and long-term bank debt become weaker, while the short-term substitution result remains more consistent. This suggests that the individual effects of *Collateral Slack* and *Credit Concentration* are more stable than the evidence on their interaction.

Financial Pressure also helps clarify the results. Firms facing greater debt-service pressure are associated with smaller subsequent increases in bank debt. This is consistent with the financial constraints literature, where constrained firms may reduce investment, abandon valuable projects, or face more limited external finance (Almeida & Campello, 2007; Campello et al., 2010). It is also consistent with the credit rationing logic of Stiglitz and Weiss (1981), since banks may restrict credit to borrowers perceived as riskier. However, *Financial Pressure* should not be treated as a clean measure of financial constraints, since it reflects both current repayment pressure and previous borrowing decisions. Its inclusion is useful mainly because it helps separate collateral and bank relationship structure mechanisms from debt-service vulnerability.

Finally, the additional analysis with *Personal Guarantees* and *Institutional Guarantees* helps assess whether the main results are capturing other forms of contractual credit support. These variables should be interpreted with caution. Personal guarantees are often used in SME lending when firm-level collateral or borrower transparency is limited, while institutional guarantees are usually designed to reduce lender risk and ease financing constraints (Avery et al., 1998; Beck et al., 2010; Lelarge et al., 2010; Ono & Uesugi, 2009; Zecchini & Ventura, 2009). In the present results, *Personal Guarantees* are negatively associated with bank debt changes, while *Institutional Guarantees* are negatively associated with overall and long-term debt changes but positively associated with short-term debt changes. This suggests that guarantees do not operate uniformly across debt maturities. However, including these variables does not change the main interpretation. *Collateral Slack* and *Credit Concentration* remain relevant for SME bank debt adjustments.

Overall, the results suggest that collateral capacity and bank relationship structure are both relevant for SME bank borrowing, but in different ways. For Portuguese SMEs, unused collateral capacity seems to be more relevant for long-term bank debt, while dependence on the main lender is positively associated with both short-term and long-term bank debt changes. The interaction evidence is more mixed. For this reason, evidence consistent with substitution should be interpreted as specific to short-term bank debt, rather than as a general result for bank debt overall.

7. Conclusion

SMEs tend to be more dependent on bank credit than larger firms and to face stronger financing frictions. In this context, collateral and the structure of bank-firm relationships may be associated with firms' bank borrowing outcomes. This dissertation studies this issue by analyzing how *Collateral Slack* and *Credit Concentration* are associated with subsequent changes in bank debt among Portuguese SMEs, using confidential firm-level data from Banco de Portugal over the 2011-2017 period.

The results suggest that both *Collateral Slack* and *Credit Concentration* are relevant for SME bank debt adjustments, although their relevance differs across maturities. *Collateral Slack* is more consistently associated with long-term bank debt changes, while *Credit Concentration* remains relevant for both short-term and long-term borrowing. The interaction evidence is more mixed: evidence consistent with the expected substitution mechanism appears only in short-term bank debt specifications, while the overall and long-term results suggest complementarity instead. The additional analysis with *Personal Guarantees* and *Institutional Guarantees* leads to broadly similar results. Therefore, the results provide stronger evidence for the direct relevance of *Collateral Slack* and *Credit Concentration* than for the interaction mechanism.

In this sense, the dissertation contributes to the SME finance literature by showing that unused collateral capacity and bank relationship structure are relevant for bank debt adjustments, but not in the same way across debt maturities. By using *Collateral Slack*, the analysis moves beyond conventional tangibility-based measures and focuses on the part of fixed assets that is not already matched with secured bank credit. This is relevant because the tangible assets reported on the balance sheet do not necessarily imply that these assets can still support additional borrowing.

These findings also have practical implications for banks and firms. For banks, the results suggest that *Collateral Slack* and *Credit Concentration* contain different information about SMEs' financing conditions: *Collateral Slack* is more relevant for long-term bank debt, while *Credit Concentration* reflects the structure of lender exposure more broadly. For SMEs, the results suggest that financing capacity may depend not only on holding tangible assets, but also on whether those assets can still support additional credit after considering existing secured bank credit and on how borrowing is distributed across lenders.

Although the dissertation provides these contributions, the analysis also has some limitations. The first limitation relates to the dependent variable, since *Net Change in Bank Debt* captures annual net changes in outstanding bank debt, thereby not showing the specific movements behind that change, such as additional borrowing, repayments, or refinancing. For this reason, the maturity-specific results should be interpreted as net adjustments within each maturity category.

A second limitation is related to the measurement of *Collateral Slack*. This variable is intended to capture unused collateral capacity, but it remains a proxy. It is constructed by comparing PPE with bank credit secured by real collateral, and therefore does not observe the exact value of the collateral pledged or the valuation applied by banks. As a result, *Collateral Slack* should not be interpreted as a direct measure of all collateral available to the firm.

The third limitation is related to endogeneity. Although the explanatory variables are lagged and the models include firm and year fixed effects, the estimates may still be affected by unobserved time-varying firm characteristics or by simultaneous changes in firms' collateral position, bank relationship structure, and bank debt. For example, firms planning to expand bank borrowing may adjust their collateral use or banking relationship before the observed change in debt occurs.

Beyond these limitations, there are also possible extensions for future research. A first extension would be to study *Personal Guarantees* and *Institutional Guarantees* in more detail. In this dissertation, these guarantees are introduced only as an additional exercise, since the main focus remains on real collateral and bank relationship structure. Future research could examine whether these guarantees substitute or complement unused real collateral capacity in supporting SME bank debt adjustments.

Another possible extension would be to examine firms without positive bank debt exposure and transitions into or out of bank borrowing. This dissertation focuses on SMEs with strictly positive effective bank debt, and therefore studies bank debt adjustments among active bank borrowers. Future research could examine whether *Collateral Slack* and *Credit Concentration* are also related to firms' entry into or exit from bank borrowing, and therefore to their participation in bank credit markets.

8. References

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9. Appendix

9.1. Appendix A – Sample Construction

Table A1: Sample Construction

The observation counts reported in this table are based on the anonymized and perturbed working files available in the BPLIM environment. Since these perturbed working files are modified for confidentiality reasons, counts involving perturbed continuous variables, such as effective positive bank debt, should be interpreted as indicative and may differ from the original data. By contrast, counts based on categorical criteria, such as firm status, fiscal year-end, accounting period, legal form, sector, or activity classification, are expected to be preserved.

CB Sample Restriction

Dataset	Unit	Restriction/Filter	Excluded Obs.
CB	Firm-year	Restriction to SMEs	8,053
CB	Firm-year	Not classified as being in business at fiscal year-end	135,001
CB	Firm-year	Not satisfying Banco de Portugal's economic activity criterion	27,237
CB	Firm-year	Fiscal year does not end in December	12,885
CB	Firm-year	Irregular accounting period (less than 350 or more than 370 days)	110,018
CB	Firm-year	Firms in liquidation	5,663
CB	Firm-year	Non-positive total assets	4,568
CB	Firm-year	Non-positive equity	761,135
CB	Firm-year	Non-standard private corporate legal forms	125,736
CB	Firm-year	Excluded sectors outside the scope of the analysis	161,778

Initial CB Sample (2010-2017):	3,148,543 firm-year obs.
CB sample after all restrictions:	1,796,469 firm-year obs.

CRC Processing

Dataset	Unit	Restriction/Filter	Obs.
CRC	Firm-bank-month	Non-December monthly observations **excluded**	44,943,294
CRC	Firm-year	December firm-bank observations **aggregated to the firm-year level**	2,238,048

Matched Sample

Dataset	Unit	Restriction/Filter	Excluded Obs.
Matched	Firm-year	CB firm-year observations without a corresponding CRC record	779,150
Matched	Firm-year	Non-positive effective bank debt	69,979
Matched	Firm-year	Missing data in the variables	407,892

Matched sample after merging CB and CRC:	1,017,319 firm-year obs.
Final Matched Sample	**539,448 firm-year obs.**

9.2. Appendix B – Research Variables

Table B1: Description of Research Variables

This table presents the definitions, measurement forms, and data sources of the main variables used in the empirical analysis. Most continuous variables are winsorized at the 1st and 99th percentiles to limit the influence of extreme observations. An exception is made for *Collateral Slack* and *Credit Concentration*, which are not winsorized because both variables are naturally bounded between zero and one, and their boundary values are economically meaningful. Selected variables are further transformed for estimation to reduce skewness, generally after winsorization, except for Firm Size, which is log-transformed before winsorization.

Variable Acronym	Variable Name	Description	Unit/Scale	Source
Dependent Variables				
$NetChangeBankDebt_t$	Net Change in Bank Debt	Annual change in total effective bank debt scaled by lagged total assets.	% of lagged TA	CB; CRC
$NetChangeBankDebt\_ST_t$	Net Change in Short-Term Bank Debt	Annual change in short-term bank debt with original maturity up to one year, scaled by lagged total assets.	% of lagged TA	CB; CRC
$NetChangeBankDebt\_LT_t$	Net Change in Long-Term Bank Debt	Annual change in long-term bank debt with original maturity above one year, scaled by lagged total assets.	% of lagged TA	CB; CRC
Independent Variables				
$CollSlack_{t-n}$	Collateral Slack	Difference between PPE and credit secured by real collateral, divided by PPE.	Ratio, bounded in [0,1]	CB; CRC
$CreditConc_{t-n}$	Credit Concentration	Share of total bank credit supplied by the firm's main lender.	Ratio, bounded in [0,1]	CRC
Control Variables				
$Size_{t-n}$	Firm Size	Natural logarithm of total assets.	$\ln(TA)$	CB
$FirmAge_{t-n}$	Firm Age	Number of years since incorporation.	Years	CB
ROA_{t-n}	Return on Assets	EBITDA scaled by total assets, expressed in percentage terms.	% of TA	CB (BPLIM)
$Liquidity_{t-n}$	Liquidity	Current ratio, defined as current assets divided by current liabilities.	$\ln(x)$	CB (BPLIM)
$FinPressure_{t-n}$	Financial Pressure	Interest expenses scaled by EBITDA.	$\ln(1+x)$	CB (BPLIM)

9.3. Appendix C – Supplementary Descriptive Evidence

Table C1: Pearson Correlation Matrix

This table presents the Pearson correlation matrix for key variables in the models, whose descriptions are provided in Appendix B - Research Variables.

Variable	1.	2.	3.	4.	5.	6.	7.	8.
1. Net Change in Bank Debt	1.000							
2. Collateral Slack	-0.047	1.000						
3. Credit Concentration	-0.113	0.115	1.000					
4. Firm Size	0.048	-0.119	-0.315	1.000				
5. Firm Age	-0.073	0.007	-0.097	0.327	1.000			
6. ROA	-0.024	0.087	0.074	-0.241	-0.185	1.000		
7. Liquidity	0.009	0.016	0.128	-0.182	0.060	0.117	1.000	
8. Financial Pressure	-0.022	-0.255	-0.190	0.155	0.080	-0.367	-0.134	1.000

Table C2: Within-Firm Variation of Main Regression Variables

This table presents the overall, between-firm, and within-firm variation of the key variables used in the models, whose descriptions are provided in Appendix B - Research Variables. Overall SD refers to the standard deviation across all firm-year observations. Between SD captures variation in firm-level averages across firms, while Within SD captures variation around each firm's own mean over time. The *Net Change in Bank Debt* variables are expressed in percentage points. This decomposition is used to assess the extent of within-firm variation available for the fixed effects regressions.

Variable	Mean	Overall SD	Between SD	Within SD	Obs.
Net Change in Bank Debt					
Net Change in Bank Debt	0.140	12.870	10.184	10.390	539,448
Net Change in ST Bank Debt	-0.044	6.359	4.413	5.514	539,448
Net Change in LT Bank Debt	0.127	11.362	8.743	9.359	539,448
Collateral Channel					
Collateral Slack	0.839	0.308	0.281	0.154	539,448
Bank Relationship Structure					
Credit Concentration	0.818	0.220	0.188	0.108	539,448
Control Variables					
Firm Size	12.986	1.442	1.445	0.229	539,448
Firm Age	16.816	11.535	11.499	1.679	539,448
ROA	11.088	9.839	9.553	5.468	539,448
Liquidity	0.644	0.958	0.921	0.451	539,448
Financial Pressure	0.140	0.196	0.183	0.117	539,448

Figure C1: Annual Mean Evolution of Net Change in Bank Debt

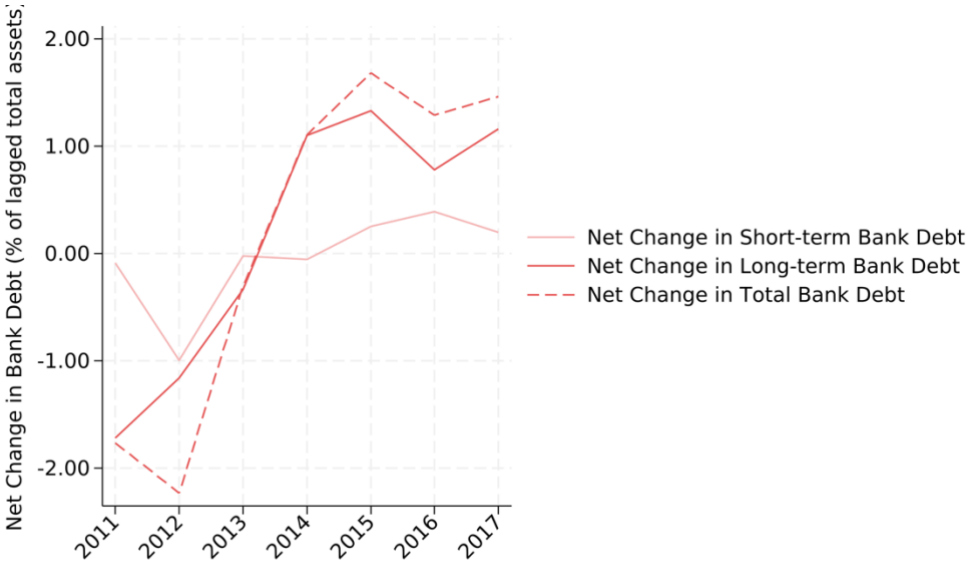


Figure C2: Annual Mean Evolution of Collateral Slack

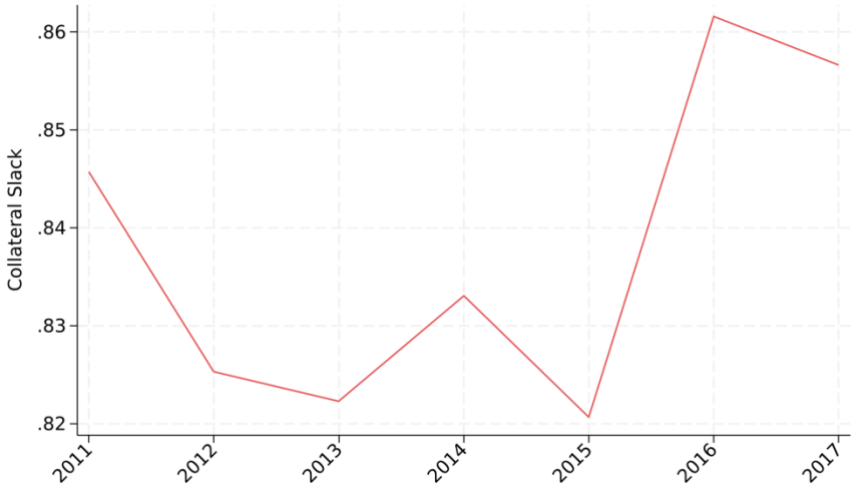
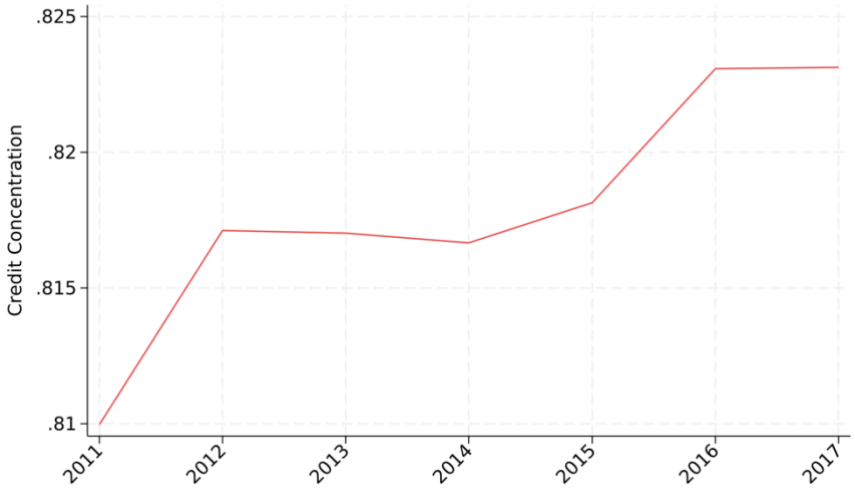


Figure C3: Annual Mean Evolution of Credit Concentration



9.4. Appendix D – Supplementary Regression Results

Table D1: Overall Net Change in Bank Debt Common Sample Regression Results

This table reports the results from fixed effects panel regressions using a common sample across the one- and two-year lag specifications. The dependent variable is the *Overall Net Change in Bank Debt*, measured as the annual change in bank debt scaled by lagged total assets and expressed in percentage points. All regressions follow the baseline specification presented in Eq. 1. Regressions (55) and (56) include *Financial Pressure* as an additional control, while Regressions (57) and (58) exclude this variable. Regressions (55) and (57) use one-year lagged explanatory variables, whereas Regressions (56) and (58) use two-year lagged explanatory variables. The sample is restricted so that the one- and two-year lag specifications are estimated on the same observations within each sample definition. All specifications include firm and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.: $NetChangeBankDebt_t$	WITH Financial Pressure		WITHOUT Financial Pressure	
	(55) *t-1*	(56) *t-2*	(57) *t-1*	(58) *t-2*
Collateral Slack	5.322*** (0.168)	2.912*** (0.158)	5.633*** (0.154)	3.202*** (0.144)
Credit Concentration	9.006*** (0.222)	4.580*** (0.208)	9.385*** (0.205)	4.938*** (0.192)
Firm Size	-8.784*** (0.160)	-5.712*** (0.136)	-7.971*** (0.143)	-5.497*** (0.123)
Firm Age	0.507*** (0.114)	0.364*** (0.106)	0.491*** (0.104)	0.407*** (0.098)
ROA	0.126*** (0.006)	0.026*** (0.005)	0.148*** (0.004)	0.053*** (0.004)
Liquidity	-0.096* (0.058)	-0.371*** (0.054)	-0.034 (0.052)	-0.343*** (0.048)
Financial Pressure	-7.130*** (0.217)	-4.330*** (0.206)		
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Obs.	329,382	329,382	380,620	380,620
Within R^2	0.074	0.030	0.065	0.029
A1	5.826	5.856	5.807	5.823
A2	9.424	9.642	9.431	9.613

Table D2: Short-Term Net Change in Bank Debt Common Sample Regression Results

This table reports the results from fixed effects panel regressions using a common sample across the one- and two-year lag specifications. The dependent variable is the *Short-Term Net Change in Bank Debt*, measured as the annual change in short-term bank debt scaled by lagged total assets and expressed in percentage points. Short-term bank debt is defined as credit exposures with original maturity up to one year, using the maturity-specific information available in the CRC. All regressions follow the baseline specification presented in Eq. 1. Regressions (59) and (60) include *Financial Pressure* as an additional control, while Regressions (61) and (62) exclude this variable. Regressions (59) and (61) use one-year lagged explanatory variables, whereas Regressions (60) and (62) use two-year lagged explanatory variables. The sample is restricted so that the one- and two-year lag specifications are estimated on comparable observations within each sample definition. All specifications include firm and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.: $NetChangeBankDebt\_ST_t$	WITH Financial Pressure		WITHOUT Financial Pressure	
	(59) *t-1*	(60) *t-2*	(61) *t-1*	(62) *t-2*
Collateral Slack	0.032 (0.088)	-0.051 (0.083)	0.096 (0.081)	0.025 (0.077)
Credit Concentration	3.205*** (0.116)	1.359*** (0.109)	3.436*** (0.108)	1.490*** (0.102)
Firm Size	-1.684*** (0.071)	-1.087*** (0.065)	-1.642*** (0.065)	-1.139*** (0.059)
Firm Age	0.060 (0.064)	0.041 (0.064)	0.056 (0.057)	0.049 (0.057)
ROA	0.021*** (0.002)	0.002 (0.002)	0.034*** (0.002)	0.008*** (0.002)
Liquidity	1.032*** (0.028)	0.379*** (0.025)	0.979*** (0.026)	0.390*** (0.023)
Financial Pressure	-2.604*** (0.135)	-1.080*** (0.125)		
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Obs.	329,382	329,382	380,620	380,620
Within R^2	0.025	0.009	0.023	0.009
A1	2.877	2.827	2.909	2.864
A2	5.161	5.203	5.212	5.249

Table D3: Long-Term Net Change in Bank Debt Common Sample Regression Results

This table reports the results from fixed effects panel regressions using a common sample across the one- and two-year lag specifications. The dependent variable is the *Long-Term Net Change in Bank Debt*, measured as the annual change in long-term bank debt scaled by lagged total assets and expressed in percentage points. Long-term bank debt is defined as credit exposures with original maturity above one year, using the maturity-specific information available in the CRC. All regressions follow the baseline specification presented in Eq. 1. Regressions (63) and (64) include *Financial Pressure* as an additional control, while Regressions (65) and (66) exclude this variable. Regressions (63) and (65) use one-year lagged explanatory variables, whereas Regressions (64) and (66) use two-year lagged explanatory variables. The sample is restricted so that the one- and two-year lag specifications are estimated on comparable observations within each sample definition. All specifications include firm and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.: $NetChangeBankDebt\_LT_t$	WITH Financial Pressure		WITHOUT Financial Pressure	
	(63) *t-1*	(64) *t-2*	(65) *t-1*	(66) *t-2*
Collateral Slack	5.185***	2.930***	5.415***	3.135***
	(0.154)	(0.141)	(0.141)	(0.128)
Credit Concentration	5.838***	3.246***	5.966***	3.464***
	(0.201)	(0.184)	(0.184)	(0.169)
Firm Size	-6.581***	-4.331***	-5.838***	-4.076***
	(0.140)	(0.118)	(0.125)	(0.107)
Firm Age	0.443***	0.327***	0.431***	0.360***
	(0.107)	(0.102)	(0.096)	(0.092)
ROA	0.102***	0.025***	0.110***	0.044***
	(0.005)	(0.005)	(0.003)	(0.003)
Liquidity	-1.228***	-0.809***	-1.111***	-0.788***
	(0.057)	(0.051)	(0.050)	(0.046)
Financial Pressure	-4.397***	-3.177***		
	(0.199)	(0.190)		
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Obs.	329,382	329,382	380,620	380,620
Within R^2	0.052	0.023	0.046	0.021
A1	5.252	5.235	5.234	5.210
A2	8.642	8.775	8.650	8.761

9.5. Appendix E – Additional Contractual Credit Support Results

Table E1: Additional Variables

This table presents the definitions, measurement forms, and data sources of the additional variables used in the additional analysis. These variables complement the main research variables reported in Appendix B – Research Variables and are included to account for alternative forms of contractual credit support. Since both variables are dummy variables, they are not winsorized or transformed for estimation.

Variable Acronym	Variable Name	Description	Unit/Scale	Source
Additional Variables				
PG_{t-n}	Personal Guarantees	Indicator equal to 1 if the firm has bank credit supported by personal guarantees, and 0 otherwise.	Dummy (0/1)	CRC
IG_{t-n}	Institutional or Public Guarantees	Indicator equal to 1 if the firm has credit covered by institutional or public guarantees, and 0 otherwise.	Dummy (0/1)	CRC

Table E2: Pearson Correlation Matrix – Additional Analysis

This table presents the Pearson correlation matrix for key variables in the models, whose descriptions are provided in Appendix B - Research Variables. Personal Guarantees is a dummy variable that takes the value of 1 if the firm has bank credit supported by personal guarantees. Institutional Guarantees is a dummy variable that takes the value of 1 if the firm has credit covered by institutional or public guarantees.

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Net Change in Bank Debt	1.000									
2. Collateral Slack	-0.047	1.000								
3. Credit Concentration	-0.113	0.115	1.000							
4. Firm Size	0.048	-0.119	-0.315	1.000						
5. Firm Age	-0.073	0.007	-0.097	0.327	1.000					
6. ROA	-0.024	0.087	0.074	-0.241	-0.185	1.000				
7. Liquidity	0.009	0.016	0.128	-0.182	0.060	0.117	1.000			
8. Financial Pressure	-0.022	-0.255	-0.190	0.155	0.080	-0.367	-0.134	1.000		
9. Personal Guarantees	0.086	-0.107	-0.346	0.082	0.007	-0.091	-0.094	0.192	1.000	
10. Institutional Guarantees	0.074	0.045	-0.325	0.159	0.090	-0.060	-0.016	0.074	0.212	1.000

Table E3: Additional Contractual Credit Support Interaction Results

This table reports the results from fixed effects panel regressions extending the augmented specification presented in Eq. 4 by adding the interaction between *Collateral Slack* and *Credit Concentration*. The dependent variables are the overall, short-term, and long-term net changes in bank debt, calculated as annual changes in total, short-term, and long-term bank debt, respectively, scaled by lagged total assets and expressed in percentage points. Regressions (67) and (68) use the *Overall Net Change in Bank Debt* as the dependent variable, Regressions (69) and (70) use the *Short-Term Net Change in Bank Debt*, and Regressions (71) and (72) use the *Long-Term Net Change in Bank Debt*. Regressions (67), (69), and (71) use one-year lagged explanatory variables, while Regressions (68), (70), and (72) use two-year lagged explanatory variables. All regressions include Personal Guarantees, Institutional Guarantees, Financial Pressure, firm fixed effects, and year fixed effects. Standard errors, reported in parentheses, are robust to firm-level clustering. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The within R^2, mean absolute residual (A1), and root mean squared residual (A2) are also reported.

Dep. Var.:	$NetChangeBankDebt_t$		$NetChangeBankDebt\_ST_t$		$NetChangeBankDebt\_LT_t$	
	(67) *t-1*	(68) *t-2*	(69) *t-1*	(70) *t-2*	(71) *t-1*	(72) *t-2*
Collateral Slack	3.873***	3.285***	0.597**	0.450*	3.487***	2.863***
	(0.421)	(0.442)	(0.237)	(0.257)	(0.375)	(0.393)
Credit Concentration	5.707***	4.284***	3.861***	2.018***	2.303***	2.377***
	(0.504)	(0.528)	(0.266)	(0.290)	(0.455)	(0.475)
CollSlack x CredConc.	2.397***	-0.198	-0.668**	-0.684**	2.599***	0.389
	(0.526)	(0.557)	(0.282)	(0.309)	(0.474)	(0.500)
Personal Guarantees	-2.931***	-0.999***	-0.652***	-0.268***	-2.218***	-0.680***
	(0.081)	(0.088)	(0.036)	(0.042)	(0.073)	(0.079)
Institutional Guarantees	-2.379***	-1.337***	0.646***	0.130***	-3.040***	-1.442***
	(0.070)	(0.078)	(0.036)	(0.042)	(0.064)	(0.071)
Firm Size	-6.616***	-5.537***	-1.460***	-1.135***	-4.614***	-4.111***
	(0.118)	(0.130)	(0.052)	(0.062)	(0.103)	(0.113)
Firm Age	0.473***	0.395***	0.018	0.027	0.453***	0.364***
	(0.087)	(0.103)	(0.043)	(0.061)	(0.077)	(0.099)
ROA	0.092***	0.029***	0.017***	0.003	0.071***	0.027***
	(0.004)	(0.005)	(0.002)	(0.002)	(0.004)	(0.004)
Liquidity	0.034	-0.333***	0.925***	0.400***	-0.981***	-0.794***
	(0.045)	(0.051)	(0.022)	(0.024)	(0.043)	(0.049)
Financial Pressure	-7.065***	-4.274***	-2.923***	-1.164***	-3.916***	-3.036***
	(0.172)	(0.191)	(0.105)	(0.115)	(0.157)	(0.177)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	481,369	351,770	481,369	351,770	481,369	351,770
Within R^2	0.079	0.034	0.026	0.010	0.060	0.026
A1	6.085	5.832	2.997	2.836	5.420	5.213
A2	9.868	9.606	5.370	5.201	8.987	8.751